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NATIONAL DAM INSPECTION PROGRAM. LAKE GORDON DAM, (NDS-242), PO--ETC(U)
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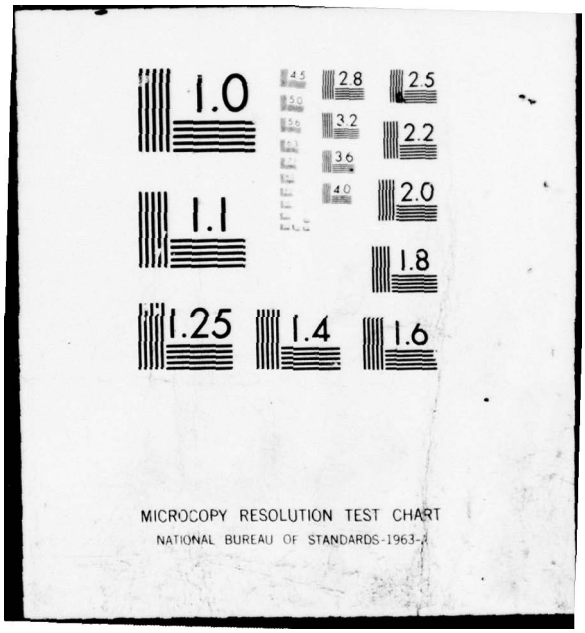
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LEVEL II

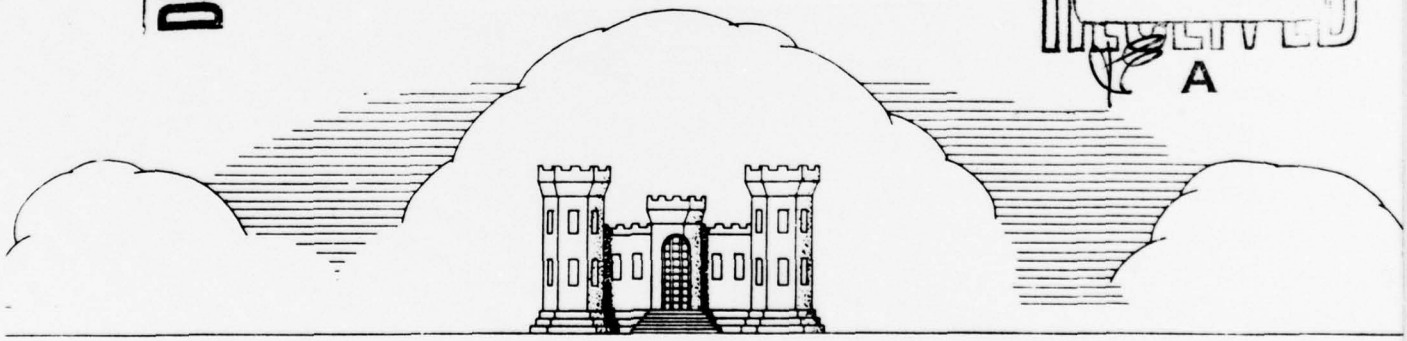
POTOMAC RIVER BASIN

(6) National Dam Inspection Program.
LAKE GORDON DAM, (NDS-242), (10)
Potomac River Basin.
COMMONWEALTH OF PENNSYLVANIA,

BEDFORD COUNTY.
Commonwealth of Pennsylvania.
INVENTORY NUMBER (NDS - 242

PHASE I INSPECTION REPORT.

NATIONAL DAM INSPECTION PROGRAM



Prepared For
DEPARTMENT OF THE ARMY
Baltimore District, Corps of Engineers
Baltimore, Maryland
by

(12) 66p.

BERGER ASSOCIATES, INC
CONSULTING ENGINEERS
HARRISBURG, PA

(11) 15 JUNE 1978

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PHASE I REPORT
NATIONAL DAM INSPECTION PROGRAM

Name of Dam: LAKE GORDON DAM

State and State Number: PENNSYLVANIA - 5-1

County: BEDFORD

Stream: EVITTS CREEK, POTOMAC RIVER BASIN

Date of Inspection: APRIL 25, 1978

Based on a visual inspection, past performance and available engineering data, the dam and its appurtenances do not appear to be satisfactory. The following recommendations are made:

1. The flashboard base and pins should be removed immediately.

2. Additional studies should be performed to ascertain the methods of enlarging the spillway capacity, including all necessary studies to ascertain the structural capacity of the dam under maximum conditions. These studies should include but not be limited to hydrologic and hydraulic analysis, foundation investigation, erosion control in case of overtopping, foundation condition embankment studies.

3. Studies and repair work should be implemented to control leakage.

4. The 48 inch blowoff should be made operable for emergencies.

The present spillway will pass only 22 percent of the PMF without overtopping and the dam is, therefore, considered to be seriously inadequate. In the event of unusual heavy precipitation an around-the-clock surveillance plan and a downstream warning system should be implemented.

Submitted By:

BERGER ASSOCIATES, INC.
HARRISBURG, PENNSYLVANIA

Date: June 15, 1978

APPROVED BY:

G. K. WITHERS
Colonel, Corps of Engineers
District Engineer

DATE: 27 Jun 78

November 6, 1978

In reply refer to
5-1
5-49

Mr. Dennis Polhill, P. E.
Director of Public Works
City of Cumberland
Cumberland, Maryland 21502

Dear Mr. Polhill:

This letter is in reference to our earlier correspondence concerning the inspections of the Lake Gordon and Lake Koons Dam located in Cumberland Valley Township, Bedford County.

Although we did receive a telephone communication on one occasion, we have not received a written reply to our request concerning the condition of each of these dams.

It is absolutely necessary that the City immediately complete an engineering study of each of these dams. These requirements were listed in our letter of July 17, 1978 and are specified in more detail in Section 7 of each of the Inspection Reports.

We also consider the development of an effective warning system for each dam a matter of the highest priority.

We expect a monthly report on the status of each dam submitted no later than the fifteenth of each month.

Sincerely yours,

Joseph J. Ellam, Chief
Dam Safety Section
Division of Dam Safety & Waterworks

JJE/ns
cc: Col. Withers
C. H. McConnell
Bill Parsons, Wmspt. Reg.
J. Coulter, Secretary, Md Dept. of Natural Resources
Paul Gardosik, Harrisburg Reg.
Dick Lamison, Civil Defense
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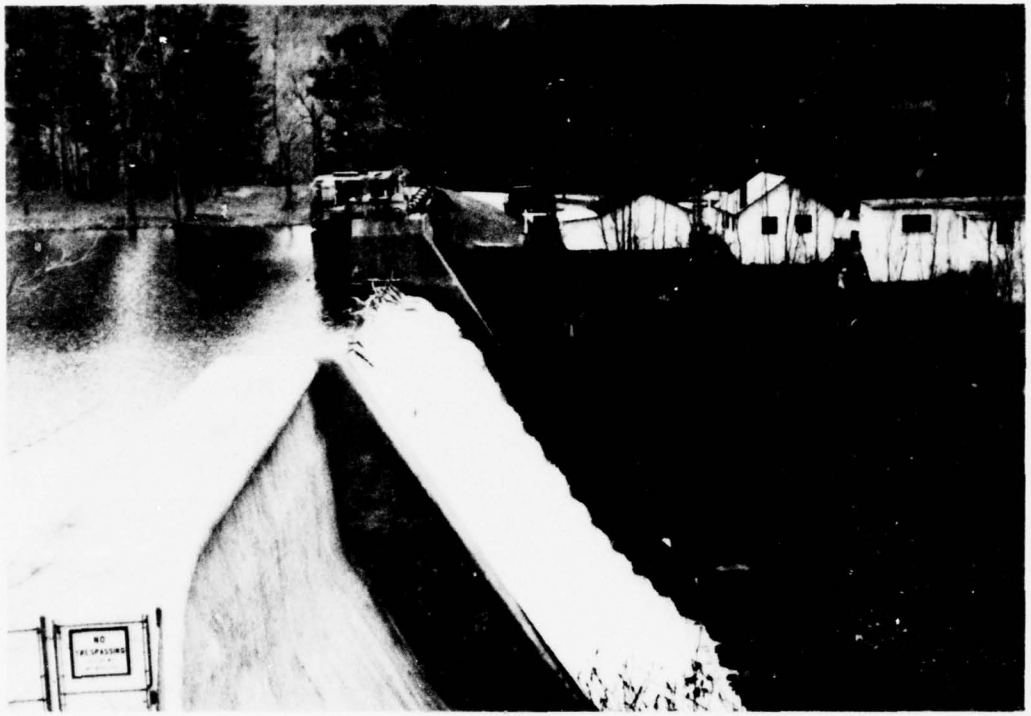


OVERVIEW

SECTION 1 - PROJECT INFORMATION

1.1 GENERAL

a. Authority

The Dam Inspection Act, Public Law 92-237 (Appendix III) authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of inspections of dams throughout the United States. Phase I Inspection and Report is limited to a review of available data, a visual inspection of the dam site and the basic hydraulic calculations to determine the adequacy of the spillway.

b. Purpose

The purpose is to determine if the dam constitutes a hazard to human life and property.

1.2 DESCRIPTION OF PROJECT

a. Dam and Appurtenances

Lake Gordon Reservoir Dam is a cyclopean masonry gravity dam. The dam is located approximately 1.3 miles downstream of the Thomas W. Koon dam which is also owned by the City of Cumberland. Total length of the dam is approximately 435 feet, including a 150 foot wide spillway. The gatehouse is located to the left of the spillway. The design spillway crest elevation was 950.0, and the top of the dam is at elevation 959.1 (Appendix D, Plates VIII and IX). The original streambed elevation was at elevation 875. A water treatment plant is located about 300 feet downstream of the dam and a 36-inch cast iron pipe runs from the gatehouse to the plant. The face of the dam and the steps to the spillway have been formed with precast concrete blocks. A 48-inch diameter pipe with a 48-inch sluice gate is not operable and there is no low level emergency drawdown facility.

b. Location: Cumberland Valley Township, Bedford County U.S. Quadrangle, Evitts Creek, MD., PA., W.VA. Latitude 39°44.5', Longitude 78°40.7' (Appendix D, Plates I and II)

c. Size Classification: Intermediate (5,300 acre-feet, height 84 feet)

d. Hazard Classification: High (see Section 3.1.d)

e. Ownership: City of Cumberland
City Hall
P. O. Box 1702
Cumberland, Maryland 21502

f. Purpose of Dam: Water Supply

g. Design and Construction History

The dam and water treatment plant were designed by James H. Fuertes, New York, for the Evitts Creek Water Company. The necessity for the dam and water supply was urgent for the City of Cumberland, due to a high incidence of typhoid cases in that city. Construction was started on June 15, 1912.

In 1924, the downstream face of the dam was deteriorating badly. During repairs on the face of the dam in December, 1925, the water level increased very fast in the lake and the 48 inch sluice gates on a blow-off pipe were opened. Logs or other debris damaged the gates and the stem which made it impossible to close the gates. Concrete was dumped down the valve chamber and this stopped most of the leakage. An additional gate was installed at the downstream end of the 48 inch blow-off pipe to stop leakage coming through the dumped concrete. In 1964 the concrete was removed and the 48 inch sluice gates were repaired. In February, 1927, a permit was given for the installation of a two-foot high flashboard.

h. Normal Operating Procedures

Some of the gates are seldom operated and water intake is controlled at the treatment plant. If the lake drops down more than three feet, additional releases are made at the upstream dam (T. W. Koon Dam). The flow to the treatment plant is not adequate with a water surface elevation more than three feet below the spillway crest elevation. Additional lift pumps were installed in 1964 with the intake pipe at a low elevation on the outside of the gatehouse. Mr. Nixon, Superintendent of the plant prefers not to use these pumps due to the high vibrations caused in the structure and the rather odorous type water obtained at this low elevation.

1.3 PERTINENT DATA

a. Drainage Area (square miles) 52.1
(Measured for this report. Original application listed 51.1 square miles).

b. Discharge at Dam Site (cubic feet per second)
See Appendix B for hydraulic calculations.

Maximum known flood at dam site (March 17, 1936) 7,500

Warm Water Outlet - Two 30-inch sluice gates at centerline elevations of 940.0 and 920.0 admit water to control tower. From the control tower, the water flows in a 36-inch feed line to the treatment plant. The feed line sluice gate has an invert elevation of 890.5. There is also an inoperative 48-inch "blow-off" sluice gate with the invert at elevation 878, which formerly discharged water to stream. The flow of water to the treatment plant can be augmented when the pool level is low by using a 24-inch pipe line and lift pumps. The 24 inch pipe carries the water over the dam.

The ungated spillway capacity at pool elevation 959.1 (top of dam) 12,800

Total maximum spillway capacity - This is a concrete gravity dam which, according to the file data, is designed to withstand flow over the entire 450 feet of its length. In addition, the file data indicates that there is provision for an emergency spillway over a 200-foot long embankment at the left (east) abutment of the dam. Thus, total discharge capacity is only limited by the structural stability of the dam and by the possibility of erosion of the abutments, overflow embankment, and streambed and banks downstream from the dam. There are no records available to assess if a concrete wall was placed in this emergency spillway and to investigate the tie-in between the dam and this embankment.

c. Elevation (feet above mean sea level)

Top of dam	959.1
Maximum pool - design surcharge	None listed
Water supply pool (includes gunite and 3 inch high x 8 inch wide plank on crest)	950.4
Spillway crest	950.4
Upstream portal invert diversion gate (inoperative)	878.0
Downstream portal invert diversion gate (inoperative)	878.0
Streambed at centerline of dam	875±
Maximum tailwater	885±

d. Reservoir (miles)

Length of pool (Lake Gordon Dam to upstream T. W. Koon Dam)	1.3

e. Storage (acre-feet)

Water supply pool (Elev. 950.4)	3,920
Top of dam (Elev. 959.1)	5,290

f. Reservoir Surface (acres)

Top of dam (Elev. 959.1)	169
Spillway crest (Elev. 950.4)	146

g. Dam (Appendix D, Plates VIII and IX)

Type: Cyclopean Masonry Gravity.

Length: 435 feet, including 150 feet spillway and a gatehouse.

Upstream Face: Vertical top and bottom section, middle section battered 10-1/2 inches over 30 feet.

Downstream Face: Different slopes (see Appendix D, Plate IX).

Top Width: 9'-6"±

Bottom Width: Varies.

Maximum Height: 84 feet above the streambed (approximately 90 feet above the bottom of the foundation).

The faces of dam are formed with precast concrete blocks. At the upstream side, a 4 foot wide cutoff wall was cut into the rock and filled with concrete. A drainage system was installed under the foundation. However, a grout curtain is not indicated.

h. Diversion and Regulating Facilities

See warm water outlet, paragraph 1.3.b.

i. Spillway

Type - Uncontrolled modified ogee. The crest has been built up with gunite. The crest is obstructed by the remains of previously

installed flashboards. These remains consist of a continuous strip of 3 inch high x 8 inch wide horizontal planking which is fastened to the crest of the weir with bolts and vertical steel pins on about 6 to 8-foot centers. These exposed pins catch and hold considerable amounts of floating debris.

Length of weir - 150 feet.

Crest elevation (top of gunite and horizontal 3" x 8" planking) 950.4

Upstream channel - The weir is in the center of the dam and is located at the deepest portion of the reservoir.

Downstream channel - From the weir, the water flows down over a steep flight of large steps which effectively dissipate the excess energy. From the bottom of these steps, the water enters the normal stream channel. The channel shows no sign of erosion. A two-span highway bridge located about 700 feet downstream of the dam is rather constricted. There is no doubt that flow will occur over the road at the left end of bridge during major floods.

j. Regulating Outlets

See warm water outlet, paragraph 1.3.b.

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

a. Data Available

1. Hydrology and Hydraulics

The only information on hydrology or hydraulics in the files, was a letter stating that Q design was 14,500 cfs.

2. Dam

The design drawings contain a geological section along a line near the centerline of the dam (Appendix D, Plate VII). The proposed dam on this drawing is not in the final location, but was constructed approximately along line A-A. Some test pits were excavated, but there was no information on the results. The dam was specified to be founded on "firm" foundation. Refer to Appendix D, Plate X for a loci of the resultants for the various loading conditions.

The assumptions were as follows:

Weight of masonry - 135#/cu.ft. Actual weight by tests made in the field appears to be 141#/cu.ft.
Weight of water: 62.5#/cu.ft.
Due to a drainage system under the dam no upward pressure was used. (It could not be established if these drains are working properly).
Maximum water elevation - 959.1

The assumed loading conditions were:

a. Water level at elevation 959.1.
b. Water level at elevation 950.0 and 20 Kips/Lin.Ft. ice pressures at elevation 949.5.
c. Empty reservoir.

The original spillway was designed for conditions a. and b. only.

3. Appurtenant Structures

Structural design analysis or criteria are not available for the gatehouse.

b. Design Features

1. Dam

Drawings (Appendix D, Plates VII through X) do not give many details of construction. There is no indication that construction or expansion joints were used. The strain summary (Appendix D, Plate X), indicates that vertical reinforcing bars should be placed on the upstream side for tension in that area, when ice pressure is assumed. The resultants for the other loading conditions fall within the middle third of the sections. A drawing dated September, 1913, presumably indicates as-built conditions, but does not show transitions from one section to the next. The right abutment (west end) has a deep excavation into rock (43 feet) and a trench of about 11.5 feet wide, with a small cutoff wall (drawing not included). This section has a transition to a section with a sloped downstream face with a very small cutoff wall. Drains are not indicated under the walls.

The spillway has steps of varying dimensions. The steps are vented with 4 inch pipes to the outside of the spillway wingwalls.

2. Appurtenant Structures

The gatehouse projects at the upstream side of the dam and has reinforced concrete walls. All gates are on the upstream side of the dam. A pair of 48-inch sluice gates at elevation 878.0 were used for by-pass during construction and were made inoperable in 1925. In 1966, this condition was repaired; however, the gates have not been used and it is questionable if they are operable. The intakes are 30 inch sluice gates at elevations 920.0 and 940.0. The 36-inch outlet at elevation 890.5 is connected to the treatment plant by a 36-inch cast-iron pipe.

c. Design Data

1. Hydrology and Hydraulics

No information is available.

2. Dam and Appurtenant Structures

The design drawings indicate the general construction information and the design assumptions. A maximum toe pressure of 4.84 tons per square foot is indicated. The location of the dam was based on a geological investigation and moved slightly southward from the original location due to the existence of a weak foundation strata.

2.2 CONSTRUCTION

The construction data available is limited to a drawing dated September, 1913, indicating some sections and the bottom of the excavation line. Letters in the file indicate that the percentage of stone in the cyclopedean masonry varied from 20% to 33% and the weight of masonry varied from 147#/cubic foot to 150#/cubic foot.

The files also indicated that the east (left) abutment was to be one foot lower than the top of the dam, and could function as an emergency spillway.

2.3 OPERATION

There are no formal records of operation available. The highest flow over the spillway occurred in 1936 when a depth of approximately 6 feet was reached. The flow over this spillway is in general, twice as deep as that at the upstream dam (T. W. Koon Dam). This is mainly due to its narrower configuration (150 feet here versus 240 feet at the T. W. Koon Dam).

2.4 EVALUATION

a. Availability

The available design drawings and correspondence files were provided by the Division of Dams and Encroachments of the Pennsylvania Department of Environmental Resources (PennDER).

b. Adequacy

1. Hydrology and Hydraulics

Hydrology and hydraulic information is nonexistent. No records were found relative to design storms, flood hydrographs, frequency curves or rating curves for spillway or outlet works.

2. Dam

The construction drawings are the only design data available for this structure. Dates on these drawings varied from 1911 to 1913 and no exact record is available to identify the as-built drawings. There are no construction progress reports in the file. The drawings contain sections of the dam and spillway, indicating the loci of resultants for various loading conditions, refer to (Appendix D, Plates IX and X). Design calculations indicating shear resistance calculations, factors of safety against overturning or uplift calculations were not found.

c. Operating Records

Formal operating records were not available for review. Descriptions of leakage problems at the abutments are in the file and were confirmed in the field.

d. Post Construction Changes

Although construction plans indicate three foot high parapets on the dam, these were either not installed or have been removed. In 1925, a contract was let for repairs to the face of the main dam, spillway and spillway wingwalls. Due to a high inflow, the 48-inch gates were opened and could not be closed. Concrete was dumped in the well to cut off the flow of water and an outside sluice gate was installed on the downstream end of the 48 inch blow-off pipe.

In 1927, approval was given for the installation of a 24 inch high flashboard, which was supposed to break if the water were to rise to 18 inches above the flashboards. Time of actual installation is not known. The flashboards caused a considerable increase in leakage at the abutments and as a result they were removed in 1977.

In 1963, a contract was let to gunite the deteriorated areas of the dam to a maximum depth of 9 feet below the spillway crest at the upstream side, and over the full face of the dam and spillway on the downstream side. In 1964, George Hazlewood Company, Cumberland, Maryland, repaired the gate chamber by removing the concrete and repairing the 48 inch gates. The two lift pumps with a low intake were installed at that time.

e. Seismic Stability

The dam is located in Seismic Zone 1 and it is considered that the static stability with normal safety factors is sufficient to withstand minor earthquake induced dynamic forces. No calculations or studies have been made to confirm this.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

a. General

The general appearance of the dam, considering its age, is good except for a few troublesome areas. The maintenance of the gates and gate stands are good. See Appendix A of this report for the visual checklist and Appendix D, Plates III, IV and V for photographs taken during the inspection.

b. Dam

The two foot high flashboards have been removed, although the pins and a 3-inch x 8-inch boards remain. These items are to be removed this summer. According to the superintendent, the flashboards had considerably increased the leakage at the abutments. Due to the amount of flow over the spillway, the condition of the spillway could not be observed, but it appeared to be reasonably good. Many exposed rock ledges on the downsteam side of the dam indicated a varying degree of weathering and showed exposed open seams discharging water.

According to the Superintendent, Mr. Nixon, the highest discharge occurred in 1936 which was approximately six feet over the spillway. The abutments were flooded with water and the discharge caused considerable amount of noise and vibrations in the structure and gave an extreme concern to the people working at the dam site. The gunite over the surface of the dam prevents a close inspection of the joints and condition of the underlying structure. Some cracking of the gunite has occurred and a large bush was growing on the left abutment section (Appendix D, Plate V). Seepage stains on the gunite surface are apparent. Some erosion has occurred at the right spillway wall. The superintendent stated that the use of the lift pumps causes considerable vibration and that they are seldom used.

c. Reservoir Area

The area of Lake Gordon is clean and well maintained. The reservoir banks do not indicate any erosion problems. The approach to the spillway is the lake and it is clear of any obstructions. The superintendent stated that soundings indicated very little siltation near the dam. The Thomas W. Koon dam, owned by the same company, is located 1.3 miles upstream of this dam (Appendix D, Plate VI).

d. Downstream Channel

The downstream channel appears to be clear and sufficiently protected by natural stone for high discharges. A skewed bridge about

700 feet downstream could obstruct high discharges. The downstream valley is developed and several small communities are located between this dam and the Evitts Creek confluence with the North Branch Potomac River in South Cumberland, Maryland. Considerable loss of life and extensive economic damage can be expected if failure of the dam would occur and, therefore, the dam is considered to be in the High Hazard Classification.

3.2 EVALUATION

At the time of inspection the observed condition of the dam and its appurtenances was fair except for the following points of concern:

a. Leakage at both abutments.

b. A maximum water depth over the spillway of 6 feet (Elev. 956±) was reached in 1936, and caused considerable concern to the employees due to the noise.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES

An interview with Mr. Nixon, Superintendent of the water company, indicated that there are no established procedures for operating the dam other than maintaining the pool at spillway crest elevation 950.4. The water taken out of the lake is carried by a 36 inch pipe to the treatment plant. If there is not sufficient inflow to the lake to maintain pool level, releases are made at the T. W. Koon Dam, which is located 1.3 miles upstream and is owned by the same company. The 30-inch sluice gates at elevation 920 and 940 are used regularly, but the 48-inch sluice gates on the blow-off pipe are not used and probably inoperable.

4.2 MAINTENANCE OF DAM

The flashboards on the spillway crest were removed last fall and this reduced the leakage at the abutments according to the superintendent. No other work has been done to the dam since the dam was gunited in 1963.

4.3 MAINTENANCE OF OPERATING FACILITIES

The 30-inch sluice gates are being operated and maintained on a regular basis. The 48-inch sluice gates are not used. The water treatment plant is located adjacent to the dam and is attended on a 24-hour basis.

4.4 EVALUATION

The general maintenance of the facilities is good, although little time is spent in rehabilitating or maintaining the downstream face of the dam. The superintendent stated that they have been trying to find the origin of the leak at the right abutment, but excavation with a backhoe did not locate it.

SECTION 5 - HYDROLOGY/HYDRAULICS

5.1 EVALUATION OF FEATURES

a. Design Data

The hydrologic and hydraulic analyses available from PennDER for Lake Gordon Dam were not very extensive. No area-capacity curve, frequency curve, unit hydrograph, design storm, design flood hydrograph, nor flood routings were submitted by the designer to PennDER.

There was a plot of cfs per square mile versus drainage area for various historic floods. From this plot the designer selected a storm of 230 cfs per square mile which is equivalent to 14,500 cfs for the drainage area figure of 63 square miles which he used. In 1912, the spillway weir opening was designed to pass this size flood. In addition, the file data indicates that the dam was designed for an overflow over its entire width of 450 feet and for a flow over the 200-foot wide embankment at the left end of the dam.

b. Experience Data

The water company superintendent reports that the 1936 flood produced a head of about six feet on the crest of the spillway. Calculations made for this inspection in Appendix B, indicate that this would be a flow of about 7,500 cfs. This figure was checked against the records for a U.S.G.S. gaging station located upstream at a point where the drainage area is 30.2 square miles. The period of record for this gaging station is from 1932 to present. Maximum recorded discharge was 5,240 cfs on March 17, 1936. If this flow is transposed to the dam site using the 0.8 power of the drainage areas, the indicated flow at the dam would be 8,100 cfs (Appendix B, Sheet 1). Since this would be reduced by the storage effect of the two reservoirs, the 7,500 cfs figure has been accepted.

The above flood was passed by the Lake Gordon Dam spillway without damage.

c. Visual Observations

On the date of the inspection, no conditions were observed that would indicate that the appurtenant structures of the dam could not operate satisfactorily during a flood event.

At one time in the past, the spillway crest of this dam was provided with two-foot-high flashboards. These flashboards were subsequently removed because the higher pool elevation caused excessive

leakage through the dam. Only the boards were removed and, at the present time, the spillway crest is obstructed by horizontal 3 inch high x 8 inch wide planks which are bolted to the crest by the vertical flashboard pins, which are inserted in holes drilled in the spillway crest, and by miscellaneous drift which catches on the pins. The above items reduce the hydraulic efficiency of the spillway opening and it appears that they should be removed.

d. Overtopping Potential

This dam is 84 feet high and the reservoir can hold 5,300 acre-feet of water. These dimensions indicate a size classification of "Intermediate". The Hazard Classification is "High" as explained in Section 3.1.d. Appendix B of this section contains the hydraulic computations.

The Recommended Spillway Design Flood (SDF) for a dam with the above classifications is the Probable Maximum Flood (PMF). The PMF for this site is 59,000 cfs but the spillway capacity to design surcharge is only 12,800 cfs.

An estimate of the combined storage effect of Lake Gordon and T. W. Koon Reservoirs indicates that these reservoirs do not have the storage available that is necessary to pass the PMF. Therefore, it can be concluded that the potential of overtopping Lake Gordon Dam exists, (See Appendix B, Sheets 3, 4 and 5).

e. Spillway Adequacy

The spillway capacity to the top of the dam is 12,800 cfs or 22 percent of peak PMF. Lake Gordon Dam is a concrete gravity dam which, according to the file data, is designed in such a way that it may be able to withstand at least some overtopping without failure. After overtopping, the areas of flow will be as follows:

Area	Elev.	Length (feet)	Estimated Coefficient "C" in $Q = CLH^{3/2}$
1. Top of overflow embankment at left end of dam	About 958.5	About 200	2.63
2. Top of dam to left of spillway	961.6	150	2.63
3. Spillway Crest	950.4	150	3.32
4. Top of wall to right of spillway	959.1	150	2.63

Calculations in the attached Appendix B show that a reservoir pool elevation of approximately 967 feet will be required to pass the PMF over the dam if there is no structural failure of any type and 50 percent PMF would reach elevation 963.0.

The spillway is considered to be seriously inadequate since it cannot pass 1/2 PMF without overtopping. Additional studies may show that the embankment at the left end of the dam will act as an emergency spillway, but this possibility cannot be assumed from the information presently available.

The possibility of a structural failure due to such an applied load is discussed in Section 6. The present information is not sufficient to make an accurate evaluation of the structural stability because it is unknown if the foundation drains were installed and are functioning. In case these drains are relieving the uplift pressures the concrete structure could withstand at least the overtopping up to elevation 963.0 (1/2 PMF).

Available information in the file did not indicate the type of subsurface materials that underlie the overflow embankment at the left end of the dam. Further studies should include subsurface investigations of the embankment and more careful measurements of the flow characteristics through the opening that would be left if the embankment were to be overtopped.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

a. Visual Observations

There is considerable cracking of the gunite surface on the downstream face of the dam, but this cracking seemed to be caused by shrinkage rather than resulting from internal dam stresses, or settlements and movements. The gunite prevented observation of the original dam surface and it was not possible to make conclusions on the condition of joints. A bush is growing on the left abutment of the dam surface. The spillway surface could not be inspected due to the amount of water falling over the steps.

b. Design and Construction Data

The only available data for review is a drawing indicating the loci of resultant forces for a typical dam section and a typical spillway section (Appendix D, Plate X). The sections were designed for a maximum pool elevation of 959.1 and no uplift under the dam was assumed.

c. Operating Records

Formal operating records are not maintained. The maximum discharge occurred in March, 1936, and was estimated to have reached 6 feet over the spillway crest. This discharge caused considerable concern to the operators, due to the rumbling noise. This statement is hearsay, because no persons were interviewed who were actually present at the site at that time. The removal of the flashboards reduced the leakage at the abutments according to the representative of the water company. However, there are no actual statistics available. Ice has never been a problem at this dam. No large amount of ice is pushed against the dam. Soundings by the water company do not indicate any excessive accumulation of silt in front of the dam.

d. Post Construction Changes

In the thirties, attempts were made to grout the dam to stop the leakage. Records are not available relative to the location and take of grout. The results of this program were not very successful. The downstream face of the dam, the top and part of the upstream face have been gunited. Permit approval for the installation of flashboards was given; however, they were removed in 1977. An intake with lift pumps, located outside the gatehouse was installed in 1974.

e. Seismic Stability

This dam is located in Seismic Zone 1 and it is considered that the static stability is sufficient to withstand minor earthquake induced dynamic forces. No studies or calculations have been made to confirm this assumption.

f. Structural Stability for Pool Levels above Elevation 959

Appendix D, Plate X, indicates the loci for different loading conditions with a maximum pool elevation of 959.0. In Appendix C, approximate calculations have been made for an assumed pool elevation of 963.0 or four feet above the top of the dam. At this elevation, approximately 50 percent of PMF would pass.

The calculations indicate that the resultant force does not fall within the middle third of the foundation. The factor of safety against overturning and sliding seems to be adequate. However, these results are based on no uplift as in the original plans. The actual condition of the foundation and the functioning of the foundation drain is vital information required to evaluate the structural stability of this dam. If uplift would be present, the factor of safety against overturning could be nonexistent.

There is at present not sufficient information available to review all design criteria for this dam under pool levels higher than the design pool level of 959. Additional information is required on the foundation rock strata and the foundation underdrain. The collection of this information and a detailed stability analysis should be a part of further investigation.

SECTION 7 - ASSESSMENT AND RECOMMENDATIONS

7.1 DAM ASSESSMENT

a. Safety

The visual inspection and operational history indicate that Lake Gordon Dam has some serious problems. Reference is made to the following observations and hearsay comments:

1. Leakage at the abutments, which increases with increased head.

2. Rumbling noises near the dam, at the time of a high discharge in 1936.

3. Seriously inadequate spillway capacity.

The SDF (Spillway Design Flood) for this dam should be equal to the PMF (Probable Maximum Flood) of 59,000 cfs. The spillway capacity is 12,800 cfs or 22% of peak PMF inflow. The chance for overtopping of the dam is considerable.

b. Adequacy of Inforamtion

The available information is not considered to be adequate to make a reasonably accurate assessment of this project.

c. Urgency

It is considered very urgent that the recommended suggestions in this section be implemented immediately.

d. Necessity for Additional Studies

It is considered necessary that the owner shall immediately initiate additional studies to investigate the following:

1. A field survey to make an accurate profile of the dam and embankments to establish possible locations of overflows and the probable route the overflow would follow.

2. Investigate the left embankment and foundations to accurately assess effect of erosion under overflow conditions on safety of the dam.

3. Investigate the feasibility of enlarging the spillway capacity.

4. Make a detailed hydraulic and hydrologic study of the T. W. Koon and Lake Gordon dams and reservoirs, including the effect of T. W. Koon Reservoir storage on the inflow to Lake Gordon.

5. Investigate the cause of the leakage at the abutments and implement design and construction methods to reduce the leakage to acceptable limits.

6. Investigate the structural adequacy of the dam including embankment based on pool levels to be expected after improving the spillway capacity. Determination of the physical properties of the dam embankment and the dam foundation material will be necessary.

7. Based on the investigation of the foundation conditions, the possibility of piping beneath the dam and through the abutments must be studied and remedial measures taken if found necessary.

7.2 RECOMMENDATIONS

a. Facilities

1. In order to improve the spillway capacity the owner should immediately remove the obstructions on the spillway crest (pins and 3 inch by 8 inch boards). It should be noted that the spillway will still be seriously inadequate after the crest is restored to its original condition.

2. Studies outlined under Paragraph 7.1.d should be initiated immediately and completed within an acceptable time frame.

b. Operation and Maintenance Procedures

The following procedures should be adopted immediately:

1. An around-the-clock surveillance during periods of high precipitation should be developed to allow detections of problems at an early stage. A formal downstream warning system should be implemented for emergencies.

2. The use of the 48 inch blow-off should be implemented immediately for cases of emergency. Downstream obstruction on this pipe should be removed.

APPENDIX A

VISUAL CHECKLIST

CHECK LIST - DAM INSPECTION PROGRAM

PHASE I - VISUAL INSPECTION REPORT

NAD NO. 242

PA. ID # 5-49 NAME OF DAM Lake Gordon HAZARD CATEGORY High

TYPE OF DAM: Gravity Concrete (Cyclopean Masonry)

LOCATION: Cumberland Valley TOWNSHIP Bedford COUNTY, PENNSYLVANIA

INSPECTION DATE 4-25-78 WEATHER Cloudy - Cool TEMPERATURE Low 50's

INSPECTORS: H. Jongsma - R. Houseal

R. Steacy - A. Bartlett

NORMAL POOL ELEVATION: 950 AT TIME OF INSPECTION:

BREAST ELEVATION: 959.1 POOL ELEVATION: 950.2

SPILLWAY ELEVATION: 950 TAILWATER ELEVATION:

MAXIMUM RECORDED POOL ELEVATION: 6'± Over Spillway (1936)

GENERAL COMMENTS:

Flashboards - have been removed.
Flashboards caused increased seepage.
Debris on flashboard pins - mostly dead tree limbs 6" - 8" diameter.
Downstream channel rocks, cobbles.
Pumps vibrate dam, when used - however, seldom used.

DAM NO. NAD 242

VISUAL INSPECTION

OUTLET WORKS	OBSERVATIONS	REMARKS & RECOMMENDATIONS
A. INTAKE STRUCTURE	Gatehouse east of spillway	
B. OUTLET STRUCTURE	48" blow-off pipe not operable.	
C. OUTLET CHANNEL	Clear, good condition Bridge has restricted opening.	
D. GATES	Good Condition, except 48" blow-off.	Make 48" gates operable
E. EMERGENCY GATE	48"	
F. OPERATION & CONTROL	Good maintenance.	
G. BRIDGE (ACCESS)	None	

DAM NO. NAD 242

VISUAL INSPECTION

SPILLWAY	OBSERVATIONS	REMARKS & RECOMMENDATIONS
A. APPROACH CHANNEL	Clear and deep	
B. WEIR: Crest Condition Cracks Deterioration Foundation Abutments	Pins for flashboards accumulate debris. Due to water could not be inspected	Remove pins and horizontal plank.
C. DISCHARGE CHANNEL Lining Cracks Spilling Basin	None	
D. BRIDGE & PIERS	None	
E. GATES & OPERATION EQUIPMENT	None	
F. CONTROL & HISTORY	Flashboards increased leakage at abutments	

DAM NO. NAD 242

VISUAL INSPECTION

MISCELLANEOUS	OBSERVATIONS	REMARKS & RECOMMENDATIONS
INSTRUMENTATION		
Monumentation		
Observation Wells	None	
Weirs	None	
Piezometers	None	
Other	None	
RESERVOIR		
Slopes	Good condition	
Sedimentation	Very little	
DOWNSTREAM CHANNEL		
Condition	Good and clear Restricted bridge opening.	
Slopes	Good	
Approximate Population	Numerous	
No. Homes	Numerous	

DAM NO. NAD 242

VISUAL INSPECTION

CONCRETE/MASONRY DAM	OBSERVATIONS	REMARKS & RECOMMENDATIONS
A. SEEPAGE	On left side on face of wall - wet spot No apparent steady flow None evident on right side.	Some growth on the wall - tree.
B. ABUTMENT JOINTS	Into rock - fractured badly at outcrops	
C. DRAINS	Not visible	
D. WATER PASSAGE	Over spillway	
E. FOUNDATION	Sandstone - see geologic report	
F. CONCRETE SURFACE	Gunited. Some deterioration on spillway chutes	
G. STRUCTURAL CRACKS	None evident - surface has been gunited. Some map cracking on gunite.	
H. HORIZONTAL & VERTICAL ALIGNMENTS	Appear o.k.	
J. MONOLITH JOINTS	Cannot observe gunite	
K. STAFFGAGE & RECORDER	Left Abutment	

APPENDIX B

HYDROLOGY/HYDRAULICS

PROJECT Dam Investigation SHEET NO. 1 OF 2
SUBJECT Lake Ponape Dam ID # 242
COMPUTED BY RPS DATE 5-1-78 CHECKED BY DRJr 5-4-78

Maximum known flood at damsite

USGS Gaging Station # 1603500 Evitts Creek near Centerville Pa. Drainage area 30.2 square miles. Record 1932 to 1978 Max. Q 5,240 cfs 3-17-36.

To transpose to damsite: $\left(\frac{52.1}{30.2}\right)^{0.8} \times 5240 = 8,100$ cfs

Water Co. manager reported about [illegible] cfs on spillway in 1936. From rating on sheet 2 this would be 7,500 cfs. Use 7,500 cfs.

Diversion [illegible] sluice gate 4' dia. invert elev. 878 ft.

For pool elev. 882 $Q = Ca\sqrt{2gh}$

$= .65 \times 12.6 \times (64.3 \times 2)^{0.5}$

$= 93$ cfs Use 100 cfs

For pool elev. 950

$Q = .65 \times 12.6 \times (64.3 \times 70)^{0.5}$

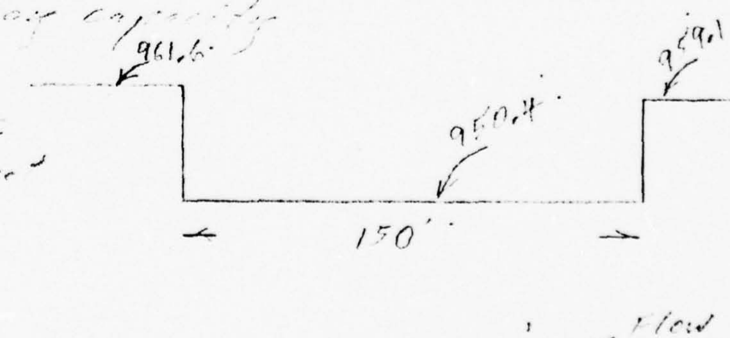
$= 549$ cfs Use 550 cfs

Note that:

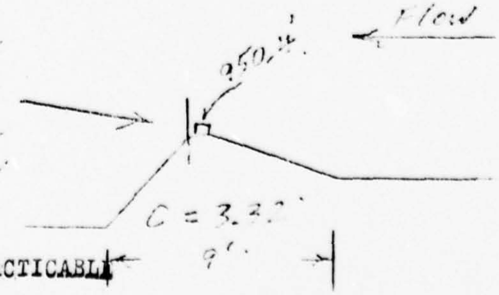
1. Above values should be considered estimates because coefficients & [illegible] are other unknowns.
2. For many years this gate has been inoperative.

Unguated spillway capacity

Earth over rock [illegible] 200 ft long at left end of dam was left at about 959 ft to provide an emergency spillway.



Remains of flash boards cont. 2" x 8" plank & 9' high [illegible] about [illegible]



See sheet 2

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PROJECT Dam Investigations
SUBJECT Lock Gordon Dam I.D. No. 247
SHEET NO. 4 OF
COMPUTED BY RES DATE 5-1-78
CHECKED BY JJPL 5-9-78

Ungated spillway capacity (Cont.)

$Q = CLH^{3/2} = 3.32 \times 150 \times ((958.1 - 950.4)^{3/2}$

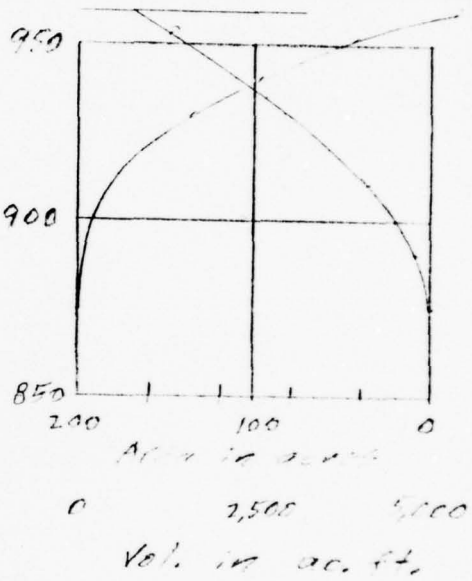
$= 498 \times (8.7)^{3/2}$

$= 12,800$ cfs.

Application for permit was originally to pass 14,500 cfs but since construction could not be raised with 0.15 of freeboard as 0.25' of planned. The above proposed flowage the value of C and the spillway

Area + storage
Based on USGS topo sheet
952 ft. = 147 acres

Elev.	Acres	Ac.-ft.	Cum. Ac.-ft.
875	0	68.	0.
890	9	145.	68.
900	20	275.	213.
910	35	455.	488.
920	56	670.	943.
930	82	960.	1613.
940	110	1321.	2573.
950.4	146	1370.	3924.
952.1	167		5294.



Spillway rating

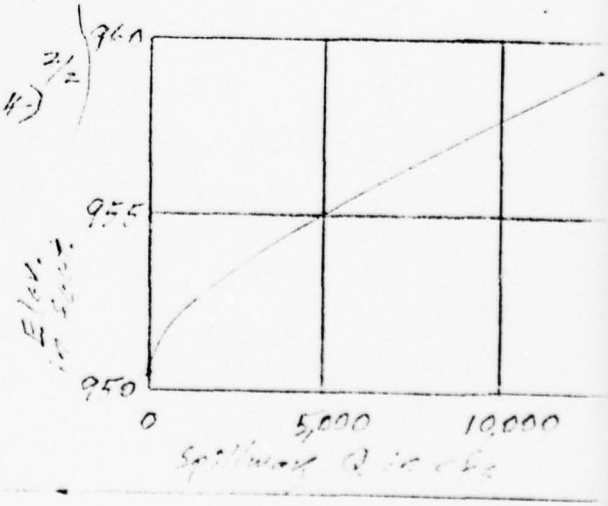
At pool = el. 955.0 ft.

$Q = CLH^{3/2}$

$= 3.32 \times 150 \times (955.1 - 950.4)^{3/2}$

$= 498 \times (11.2)^{3/2}$

$= 14,910$ cfs.



PROJECT Dam Investigation SHEET NO. 2 OF 4

SUBJECT Lake Gordon Dam ID # 242

COMPUTED BY KES DATE 6-12-78 CHECKED BY JJR 6-13-78

Size classification

Storage = 5,290 acre feet to top of dam
Height of dam = 24 feet

Size classification = "Intermediate"
From "Recommended Guidelines for Safety Inspection of Dams"

Hazard Potential classification

Failure of this dam could cause considerable loss of life and excessive economic loss in the South Cumberland, Tn. urban area

Hazard Potential classification = "High"
From "Recommended Guidelines for Safety Inspection of dams"

Spillway Design Flood

The above classifications indicate that the SDF should be the Probable Maximum Flood (PMF).
From "Recommended Guidelines for Safety Inspection of Dams"

PMF

Drainage area controlled by T. V. Koon Dam, 1.3 miles upstream	44.2 sq. mi.
Drainage area between dams	7.9
Drainage area upstream from Lake Gordon Dam	52.1

PMF values shown below are from relation curves furnished by Nash. Distr. Corps of Eng.

PMF for 52.1 sq. mi. = 1,300 csm
= 67,700 cfs

For Koon dam this would be

$$\left(\frac{44.2}{52.1}\right)^{0.8} \times 67{,}700 = 59{,}400 \text{ cfs}$$

PROJECT Dam Evaluation Study SHEET NO. 4 OF 7
SUBJECT Lake Gordon Dam - ID # 242
COMPUTED BY RES DATE 6-12-78 CHECKED BY JJN 6-13-78

PMF (Cont.) Relations shown below are from short cut flood routing method furnished by Bolt Dir. Corps of Engr. Assume Peak outflow from Knox Dam is 54,000 cfs. Then max. pool elev. = 1036. and Reserv. change in storage is

12,100 − 6,790 = 5,310 ac. ft.

See computations for Knox Dam.

Vol. of inflow = 24.5"

$$= \frac{24.5}{12} \times 44.2 \times 640 = 57{,}800 \text{ ac. ft.}$$

$$\frac{\text{Resv Storage}}{\text{Vol of Inflow}} = \frac{5310}{57{,}800} = 0.09$$

From relations $\frac{\text{Peak outflow}}{\text{Peak inflow}} = 0.91$

Peak outflow = 0.91 × 59,400 = 54,000 cfs

For the 7.9 sq. mi. uncontrolled inflow use 1,300 cfsm = 10,270 cfs

Estimate 50% reduction for offset in storage.

0.5 × 10,270 = 5,100 cfs

Total estimated PMF inflow to Lake Gordon

= 54,000 + 5,000 = 59,000 cfs.

Overtopping Potential

$$\frac{\text{Maximum spillway Q}}{\text{Peak Inflow (PMF)}} = \frac{12{,}800}{59{,}000} = 0.22$$

$$\frac{\text{Req. Res. Storage}}{\text{Vol. of Inflow}} = 0.78$$

Vol. of Inflow = Knox Outflow + Uncontrolled Inflow

Knox Outflow = 61,100 − 4,900 = 56,200 ac. ft.

(See Knox Dam calculations)

$$\text{Uncontrolled} = \frac{24"}{12} \times 7.9 \times 640 = 10{,}100 \text{ ac. ft.}$$

Total Vol. of inflow = 56,200 + 10,100 = 66,300 ac. ft.

PROJECT Dam Investigation SHEET NO. 5 OF 7

SUBJECT Lake Geetaw Dam ID # 242

COMPUTED BY REL DATE 6-12-78 CHECKED BY JJP 6-13-78

Overtopping Potential (Cont'd).

Req. Ret. Storage = 0.78 × Vol. of Inflow.

= 0.78 × 66,300

= 51,700 ac. ft.

Available storage = 5290 - 3924

= 1366 ac. ft.

Dam will be overtopped.

Discharge rating for dam assuming that it is structurally able to withstand the PMF.

The left abutment of the dam type is to a ridge whose top elevation is about 958.5. The ridge is about 10 feet wide and extends for a distance of about 200 feet before it abuts against higher land. On the far side of the ridge there is a valley which leads to Erith Creek downstream from the dam.

In this investigation, it was not possible to determine the exact elevation of the top of the ridge or the nature of the subsurface material. Notes made by the designer (about 1912) indicate that he regarded this ridge of embankment as an emergency spillway which would pass excess flows if the capacity of the spillway was exceeded. It may very well be that there is firm rock under the earthy surface of the ridge.

The following two sheets contain calculations based on the assumption that the left bank ridge can withstand overtopping.

It is recommended that additional studies be made to determine the top elevation and subsurface nature of this ridge or embankment.

PROJECT Dam Inspection

SUBJECT Lake Tanker Dam ID # 242 SHEET NO. 6 OF 7

COMPUTED BY RLS DATE 5-7-78 CHECKED BY VJPJr 5-9-78

Rating for flow over entire dam crest controlled to left of Sta. .

Pool elevation 965 ft.

1. Emergency spillway

$Q = CLH^{3/2} = 2.63 \times 200 \times (965 - 958.5)^{3/2}$

$= 526 \times (6.5)^{3/2}$ (see notes on sheet 5)

$= 8700$ cfs 8,700

2. Left wall

$Q = CLH^{3/2} = 2.63 \times 150 \times (965 - 961.6)^{3/2}$

$= 394 \times (3.4)^{3/2}$

$= 2,500$ cfs 2,500

3. Spillway

$Q = CLH^{3/2} = 3.32 \times 150 \times (965 - 950.4)^{3/2}$

$= 498 \times (14.6)^{3/2}$

$= 27,800$ cfs 27,800

4. Right wall

$Q = CLH^{3/2} = 2.63 \times 150 \times (965 - 958.1)^{3/2}$

$= 394 \times (6.9)^{3/2}$

$= 5,600$ cfs 5,600

Total Q 965 44,600

For elevation 968 ft.

1. $526 \times (968 - 958.5)^{3/2} = 15,400$ 15,400

2. $394 \times (968 - 961.6)^{3/2} = 6,400$ 6,400

3. $498 \times (968 - 950.4)^{3/2} = 36,800$ 36,800

4. $394 \times (968 - 958.1)^{3/2} = 10,500$ 10,500

Total Q 968 69,100

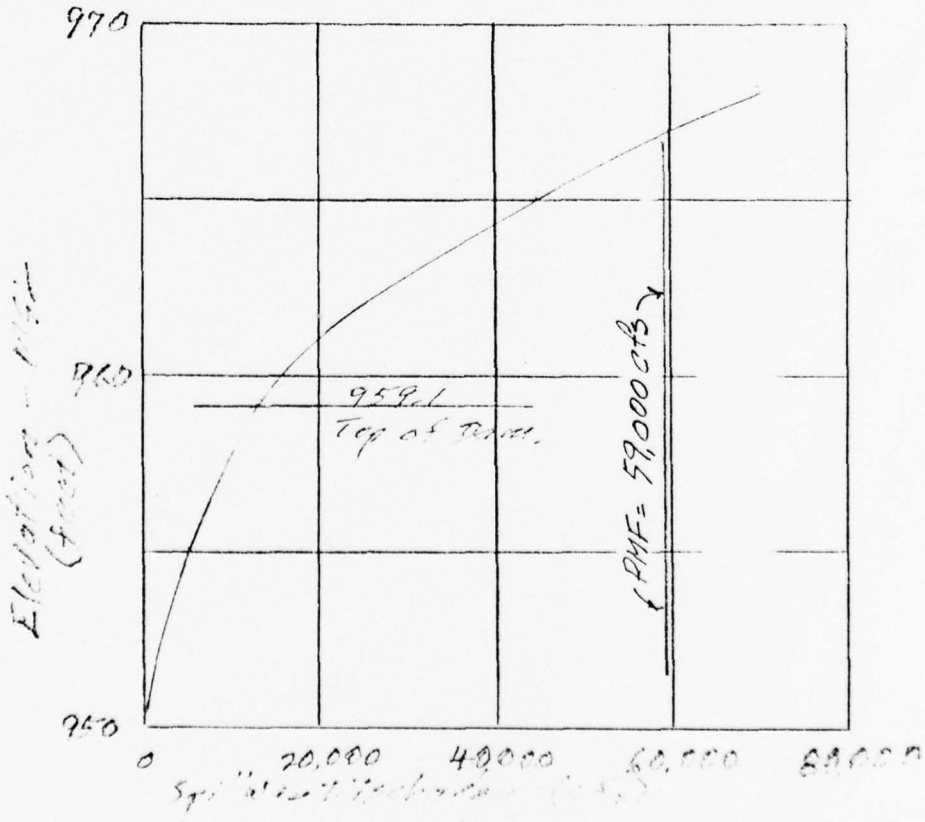
Corrections for surcharge storage are not warranted because of the approximate nature of the assumptions used.

PROJECT Dam Safety Program SHEET NO. 9 OF 1

SUBJECT Lake Gordon Dam ID # 242

COMPUTED BY RLC DATE 5-2-78 CHECKED BY JJPJr

5-9-78



APPENDIX C

GEOLOGICAL REPORT
STRUCTURAL STABILITY

GEOLOGIC REPORT

Bedrock - Dam

Formation Names: Ridgely Sandstone and Shriver Formation (Oriskany Group).

Lithology: The Ridgely Sandstone (150 feet thick) is a medium gray to light bluish gray sandstone, abundantly fossilliferous. It is composed of quartz and calcite grains cemented by calcite. Some beds are so calcareous that they could be called sandy or silty limestone. The Ridgely is thick bedded, beds being two to eight feet thick. The rock weathers to a light to dark brown, porous sandstone. Some beds completely disintegrate on weathering to loose yellow sand. The Ridgely grades down into the Shriver Formation (formerly called the Shriver Chert). The Shriver (160 to 170 feet thick) is composed of gray to black, siltstone, chert and shale. The upper part (near the Ridgely) is very calcareous, essentially a silty, cherty limestone. The calcite leaches out on weathering, leaving a yellow to brown punky rock. On the published geologic map of the Evitts Creek Quadrangle, which includes the Lake Gordon Dam (see reference 1), the Ridgely and Shriver Formation are not separated, and are mapped as the Oriskany Group. Field inspection, and interpretation of the cross section in the dam design, shows that the contact is in the right abutment of the dam, while most of the dam is founded in the Ridgely.

Bedrock - Reservoir

Formation Names: The following formations are exposed around the shores of Lake Gordon: (listed from oldest to youngest) Wills Creek Formation, Tonoloway Limestone, Keyser Limestone, Mandata Formation, Shriver Formation, Ridgely Formation, Needmore Shale and Marcellus Shale.

Lithologies: The Wills Creek is composed of dark gray to greenish gray calcareous shale and mudstone, about 500 feet thick. The Tonoloway is a very dark gray, laminated argillaceous limestone, about 550 feet thick. The Keyser is a gray to dark gray crystalline limestone, very fossilliferous, with some nodular chert. It is nearly 300 feet thick. The Mandata Formation is a thin unit, 20 feet thick, of light gray calcareous shale. The Shriver Formation and Ridgely Sandstone are described in the previous paragraph. The Needmore Shale is a dark, brownish gray, soft, calcareous shale and mudstone. The Marcellus Shale is a black, soft carbonaceous shale.

Structure

The valley of Evitts Creek is a complex syncline, in which, the shales, sandstones and limestones described above have been folded into sharp, tight folds, some of which are overturned. The Lake Gordon Dam is located on the southeast limb of a small, overturned anticline. On the east side of the dam the beds dip 8°SE and on the west side, the dip is 15°SE. The strike of the beds is about N35°E. The attitude of joint planes was measured at several outcrops near the dam (see appendix). Figure 2 is a stereographic plot of the poles to the measured joint planes. Also, on this plot is the pole to the bedding, labeled B, and the pole to a vertical plane through the axis of the dam (D-D). As most of the joints have very high dip angles, their poles plto around the edge of the plot. For explanation of the shaded field, see discussion below.

Overburden

Little information is available on the depth of overburden. The geological section of the dam, from the design report, shows three test pits. Two of these, "E" and "D" on the right bank of Evitts Creek show five to ten feet of "earth", presumably weathered bedrock and talus. The third, pit "C", penetrated 20 feet of "yellow and reddish-yellow sandstone and sand". This is typical of deeply weathered Ridgely Sandstone. This zone is not included in the dam foundation area.

Aquifer Characteristics

Where fresh and unweathered the Ridgely and Shriver Formations are composed of essentially impermeable rock and the movement of groundwater is confined to bedding planes and fractures. However, the Shriver Formation and those parts of the Ridgely Sandstone having carbonate cement are susceptible to solution by groundwater movement. Both have a high proportion of non-carbonate minerals, so that, the development of large caves and sinkholes is unlikely, but enlargement of openings on water bearing fractures does occur. One such enlarged joint was observed on the left side of Evitts Creek, directly below the water treatment plant. A small flow of water, about 1 gpm was coming out of this opening on April 25, 1978.

In weathered exposures the Ridgely is very porous due to the dissolving out of the carbonate cement and fossil shell fragments.

Discussion

Brief consideration has been given to whether there are any surfaces present (bedding or joints) which could act as slippage planes and facilitate failure of the dam foundation. It was assumed that such surfaces would have a strike making an angle of 45°, or more, to the axis of the dam, and dip toward the reservoir at angles of less than 45°, that is, slope up away from the dam. The shaded field on the stereographic projection of poles to joints would contain poles to all such planes. No points on the diagram fall close to the field. It is concluded, therefore, that there are no existing surfaces in the rock that would obviously facilitate failure of the foundation. No evidence was found of leakage through solution channels. The one solution opening found was not near the dam and the flow of water was small. The increase in the size of this opening, as the result of continued flow due to solution, is a very slow process. It is possible, however, that a clay plug somewhere in the solution channel could fail, causing a dramatic increase in the flow. This was most likely to happen during the initial filling of the reservoir, and is considered unlikely now, after all these years.

Sources of Inforamtion

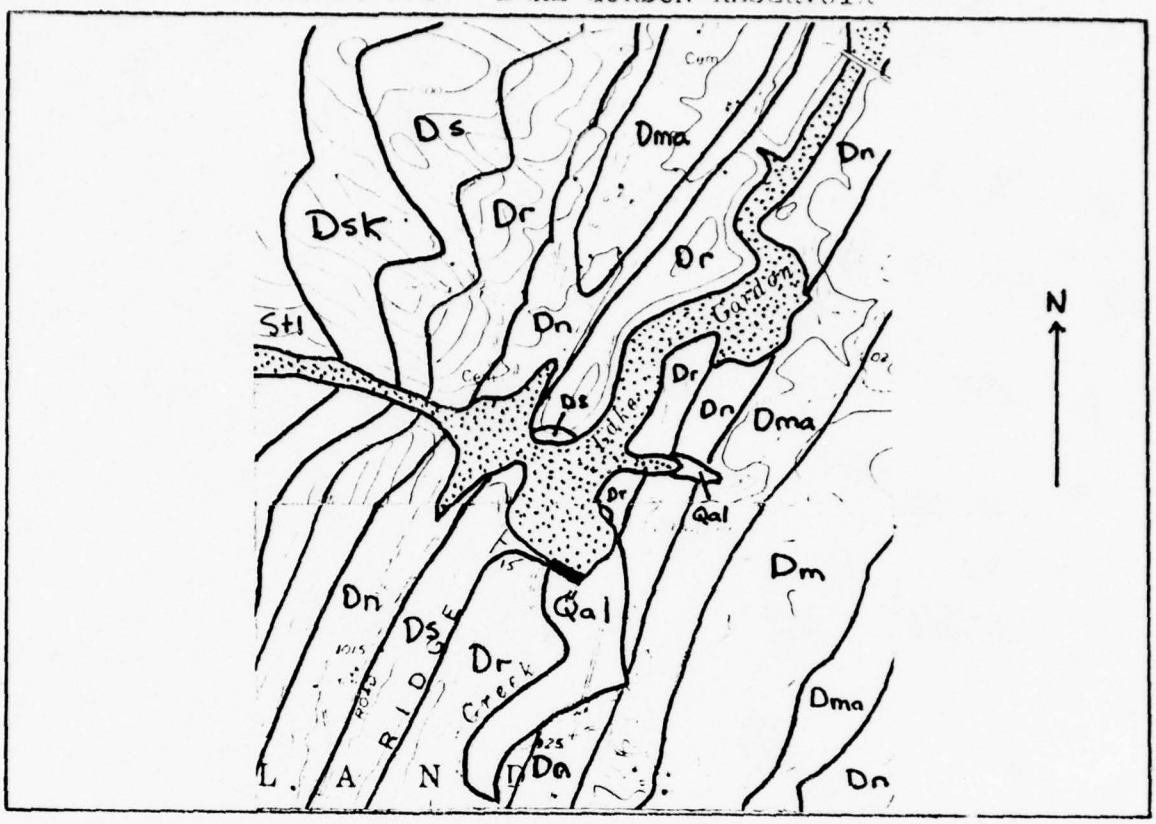
1. DeWitt, Wallace and Colton, G.W. (1964) "Bedrock Geology of the Evitts Creek and Pattersons Creek Quadrangles, Md., Pa. and W. Va." U. S. Geological Survey, Bulletin 1173.

2. DeWitt, Wallace (1974) "Geologic Map of the Beans Cove and Hyndman Quadrangles, Bedford County, Pa." U.S. Geological Survey, Misc. Investigations Series, Map I-801.

3. Air Photos, scale 1:24,000, dated 1966.

4. Plans, dated 1913.

GEOLOGIC MAP - LAKE GORDON RESERVOIR



(geology from USGS Bulletin 1175 and USGS Map I-801

Qal	alluvium	Ds	Shriver Fm.
Dm	Mahantango Fm.	Dsk	Keyser Limestone
Dma	Marcellus Shale	Stl	Tonoloway Limestone
Dn	Needmore Shale		strike and dip
Dr	Ridgeley Sandstone		

SCALE 1:24000

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 KILOMETER

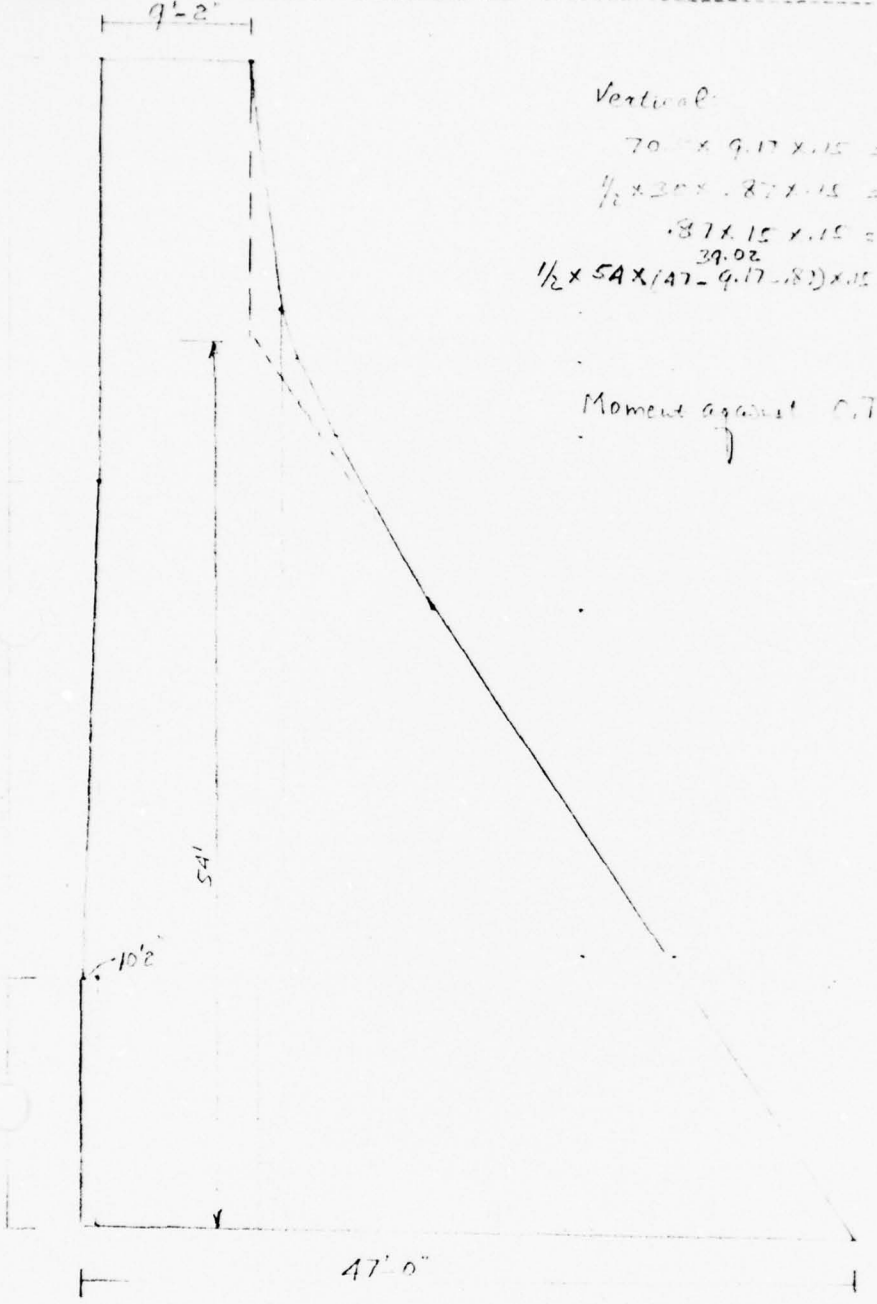
CONTOUR INTERVAL 20 FEET

Figure 2.

LAKE GORDON DAM

Stereographic Plot of Poles to Joints
(see text for explanation)

UJECT



Vertical:

70 × 9.17 × .15 = 97.0 × (.87 + 4.58) = 523

½ × 30 × .87 × .15 = 2.0 × .58 = 1

.87 × .15 × .15 = 2.0 × .43 = 1

½ × 54 × (47 − 39.02 − 9.17 − .87) × .15 = 158.0 × (9.17 + .87 + 13) = 3641

259.0^k (× 16.1') = 4172

Moment about C.T. 259 × (47 − 30.9 − 16.1) = 8003 K'

HORIZONTAL:

.25 × 70.5 = 17.63 × 35.28 = 622 K'

½ × 4.40 × 70.5 = 155.1 × 70.5/3 = 3645

172.7^k 4267 K'

SUBJECT

F.O.S. against overturning $\frac{8003}{4276} = 1.87$ OK

$M = 4276 - 259\,(30.9 - 23.5) = 2360\,K$ $\quad e = \frac{2360}{259} = 9.11' > \frac{47}{6} = 7.83$

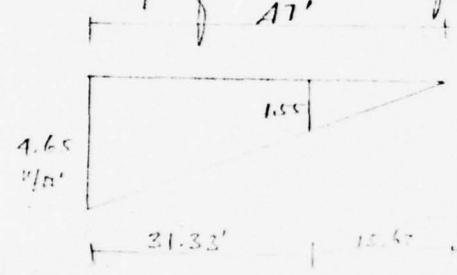
$L = (23.5 - 9.11)\,3 = 43.17'$

$P_{max} = \frac{259 \times 2}{43.17} = 12\ K/D'$

Sliding Resistance: $R = \Sigma V \operatorname{tg} \varphi + SA$

$= 259 \times \operatorname{tg} 51^\circ + 1.5 \times 47 = 370 + 70 = 440\,K'$

Assume uplift over 2/3 of area:

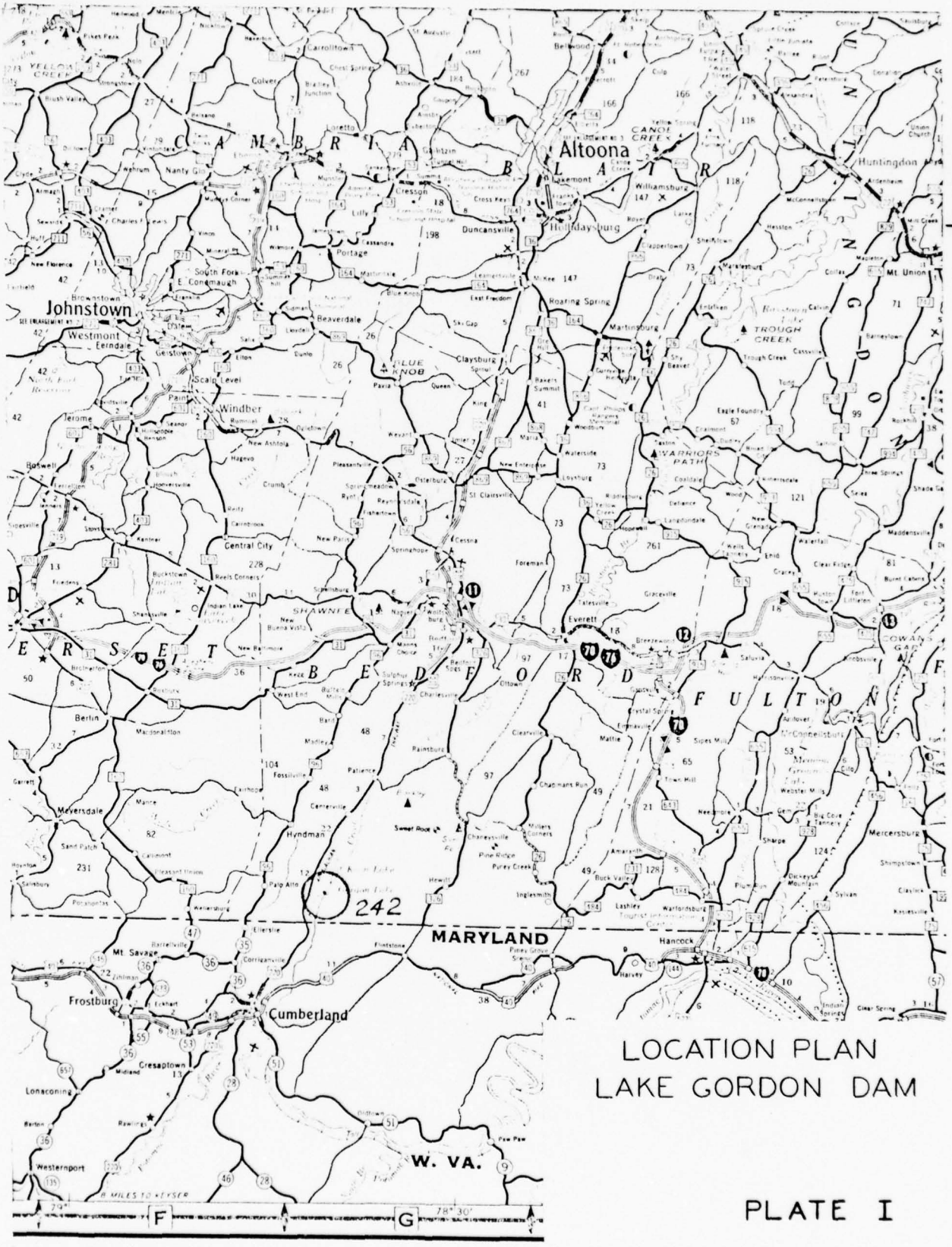


Vertical	$259 \times 30.9 =$	8003
$-1.55 \times 31.33' =$	$-48.7 \times 31.33 =$	-1521
$\frac{1}{2} \times 3.10 \times 31.33 =$	$-48.6 \times 36.56 =$	-1775
$161.7\,K \times 29.1' =$		$4707\,K'$

F.O.S. Overturning $\frac{4707}{4276} = 1.1$

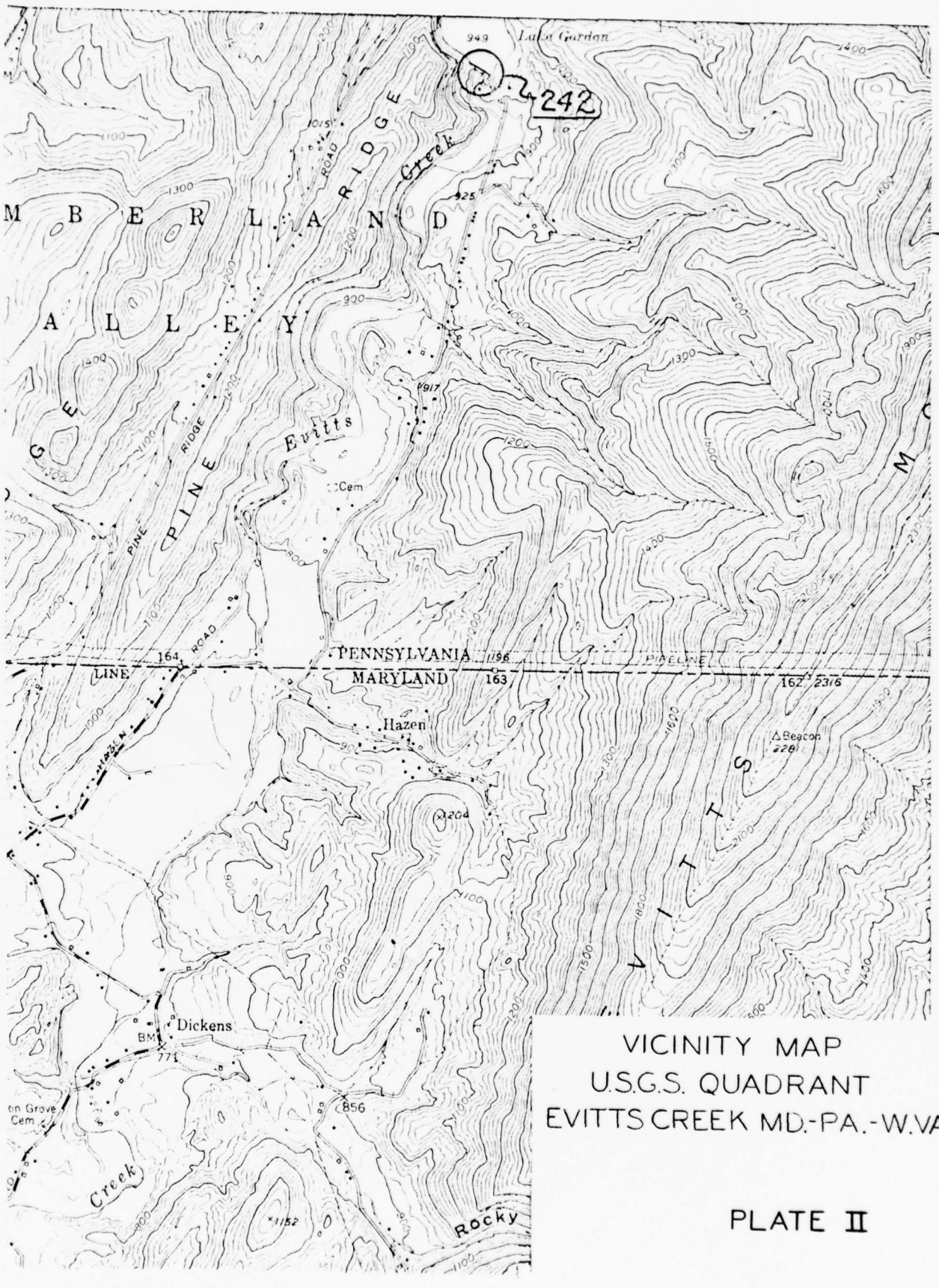
APPENDIX D

LOCATION, PHOTOGRAPHS & DESIGN DRAWINGS



LOCATION PLAN
LAKE GORDON DAM

PLATE I

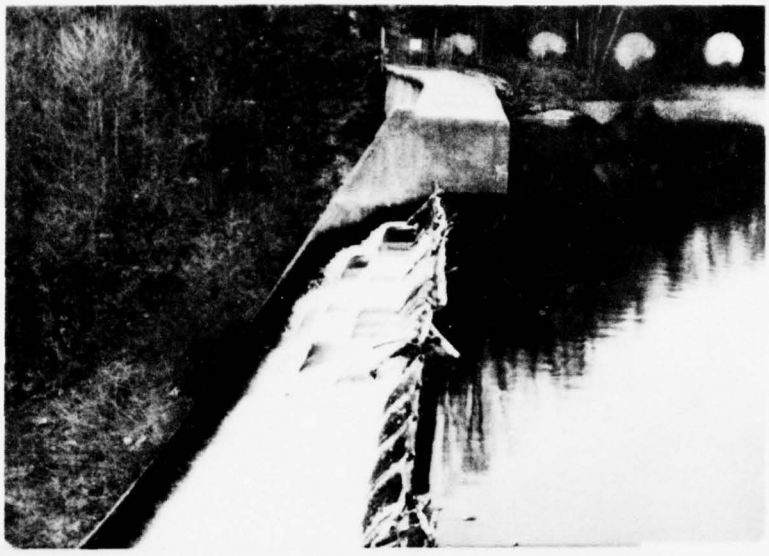


VICINITY MAP
U.S.G.S. QUADRANT
EVITTS CREEK MD.-PA.-W.VA.

PLATE II

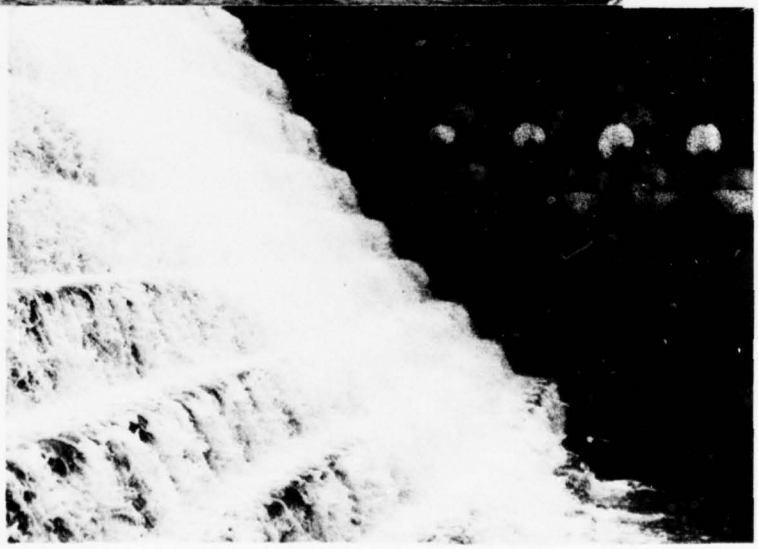
Upstream Face of Dam

PLATE III



Spillway
Looking Westward

Spillway

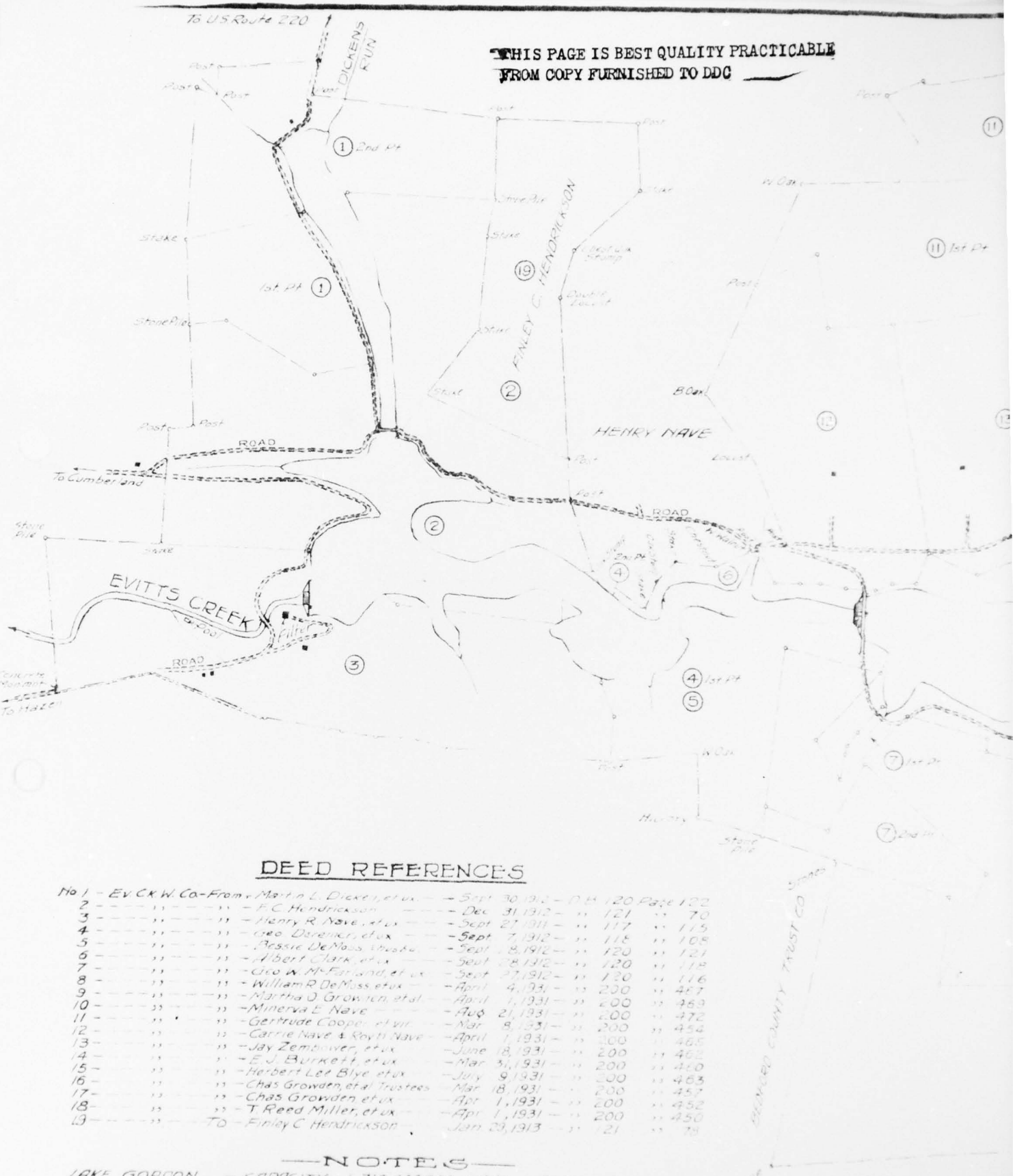


Steps in
Spillway

PLATE IV

Left Abutment

PLATE V



DEED REFERENCES

No 1	Ev. Ck. W. Co.	From	Martin L. Dickens, et ux	Sept 30, 1912	D.B. 120	Page 122
2	"	"	F.C. Hendrickson	Dec 31, 1912	" 121	" 70
3	"	"	Henry R. Nave, et ux	Sept 27, 1911	" 117	" 115
4	"	"	Geo. Dorsner, et ux	Sept 7, 1912	" 118	" 109
5	"	"	Bessie DeMoss, trustee	Sept 18, 1912	" 120	" 121
6	"	"	Albert Clark, et ux	Sept 18, 1912	" 120	" 119
7	"	"	Geo W. McFarland, et ux	Sept 27, 1912	" 120	" 116
8	"	"	William R. DeMoss, et ux	April 4, 1931	" 200	" 467
9	"	"	Martha J. Growden, et al	April 1, 1931	" 600	" 469
10	"	"	Minerva E. Nave	Aug 21, 1931	" 200	" 472
11	"	"	Gertrude Cooper, et vir	Mar 9, 1931	" 200	" 454
12	"	"	Carrie Nave & Roy B. Nave	April 7, 1931	" 200	" 465
13	"	"	Jay Zembower, et ux	June 18, 1931	" 200	" 462
14	"	"	E.J. Burkett, et ux	Mar 31, 1931	" 200	" 460
15	"	"	Herbert Lee Blye, et ux	July 9, 1931	" 200	" 463
16	"	"	Chas Growden, et al Trustees	Mar 18, 1931	" 200	" 457
17	"	"	Chas Growden, et ux	Apr 1, 1931	" 200	" 452
18	"	"	T. Reed Miller, et ux	Apr 1, 1931	" 200	" 450
19	"	TO	Finley C. Hendrickson	Jan 29, 1913	" 121	" 78

NOTES

LAKE GORDON — CAPACITY = 1,310,000,000 GALS. — AREA = 133 ACRES
THOS. W. KOON LAKE — " 2,316,000,000 " — " 258 "
EVITTS CREEK WATER CO. BOUNDARY LINES — SHOWN — — — — — —
" " " " AREA OF PROPERTY = 366.9 ACRES — PER DEEDS

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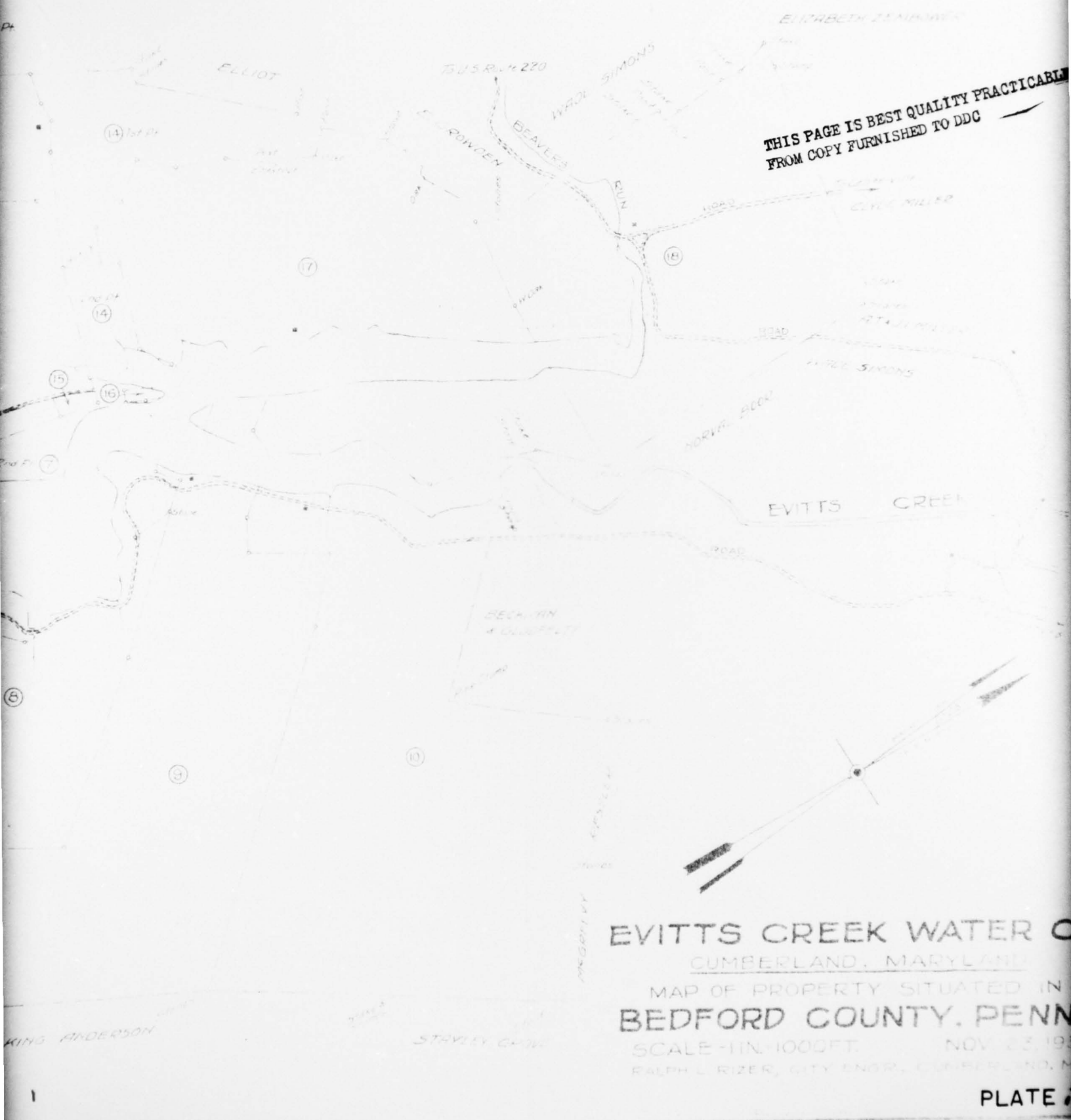
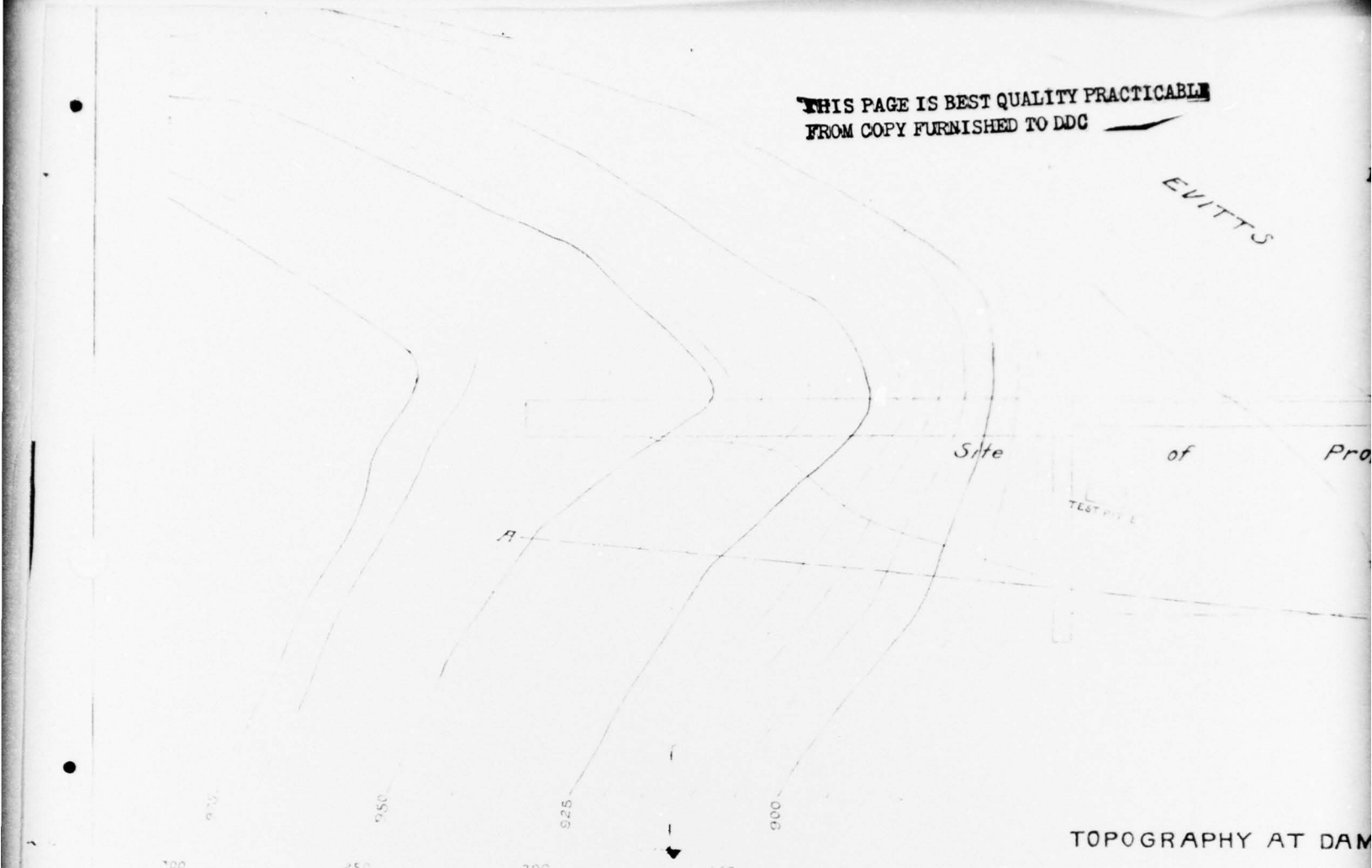
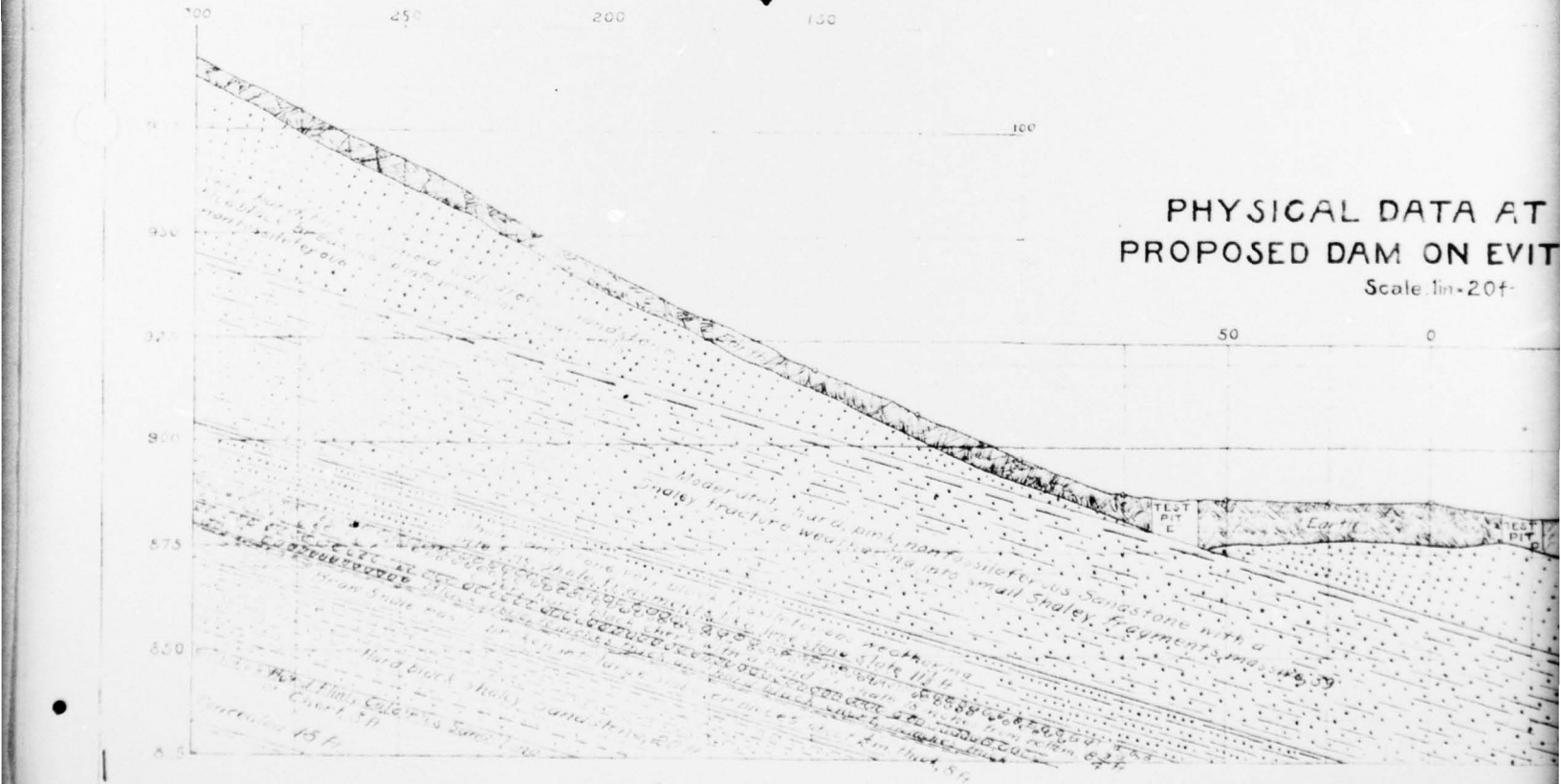


PLATE

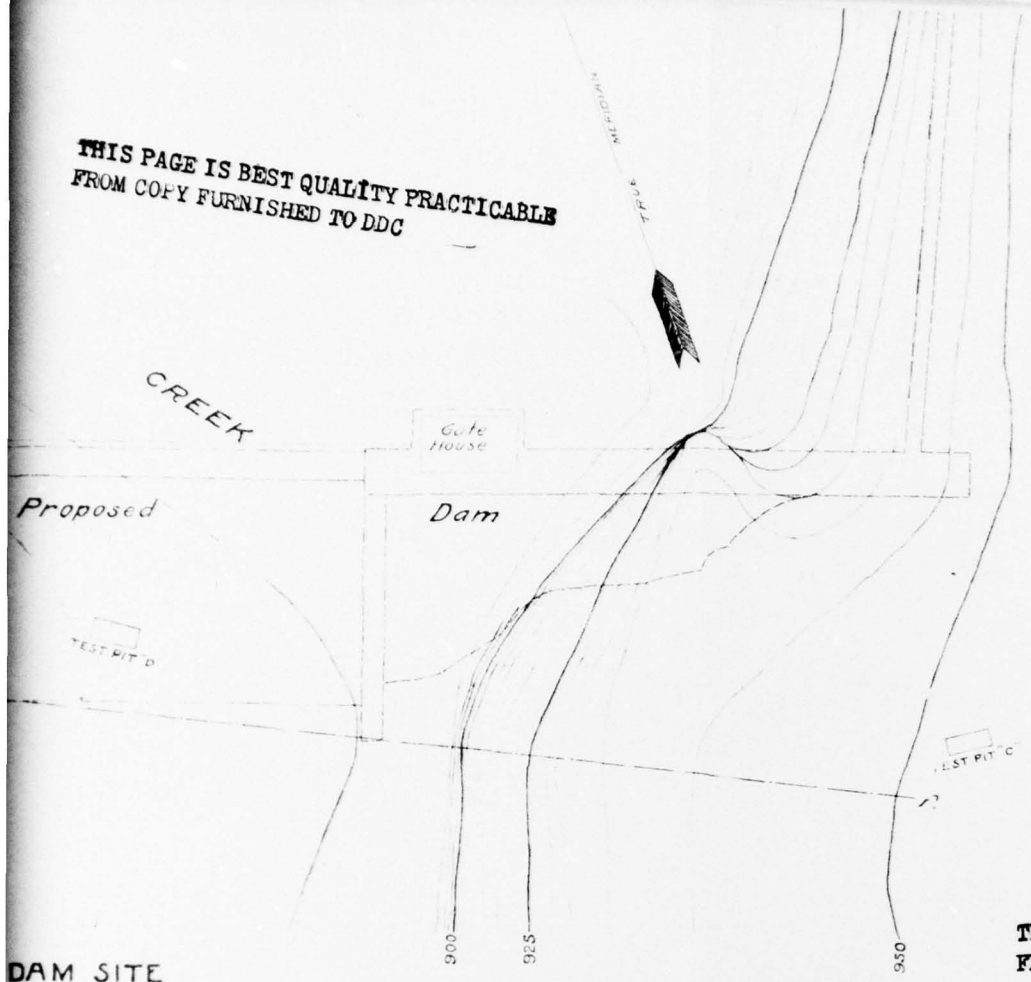


TOPOGRAPHY AT DAM



PHYSICAL DATA AT
PROPOSED DAM ON EVIT
Scale: 1in.=20ft.

GEOLOGICAL SECTION ALONG



DAM SITE

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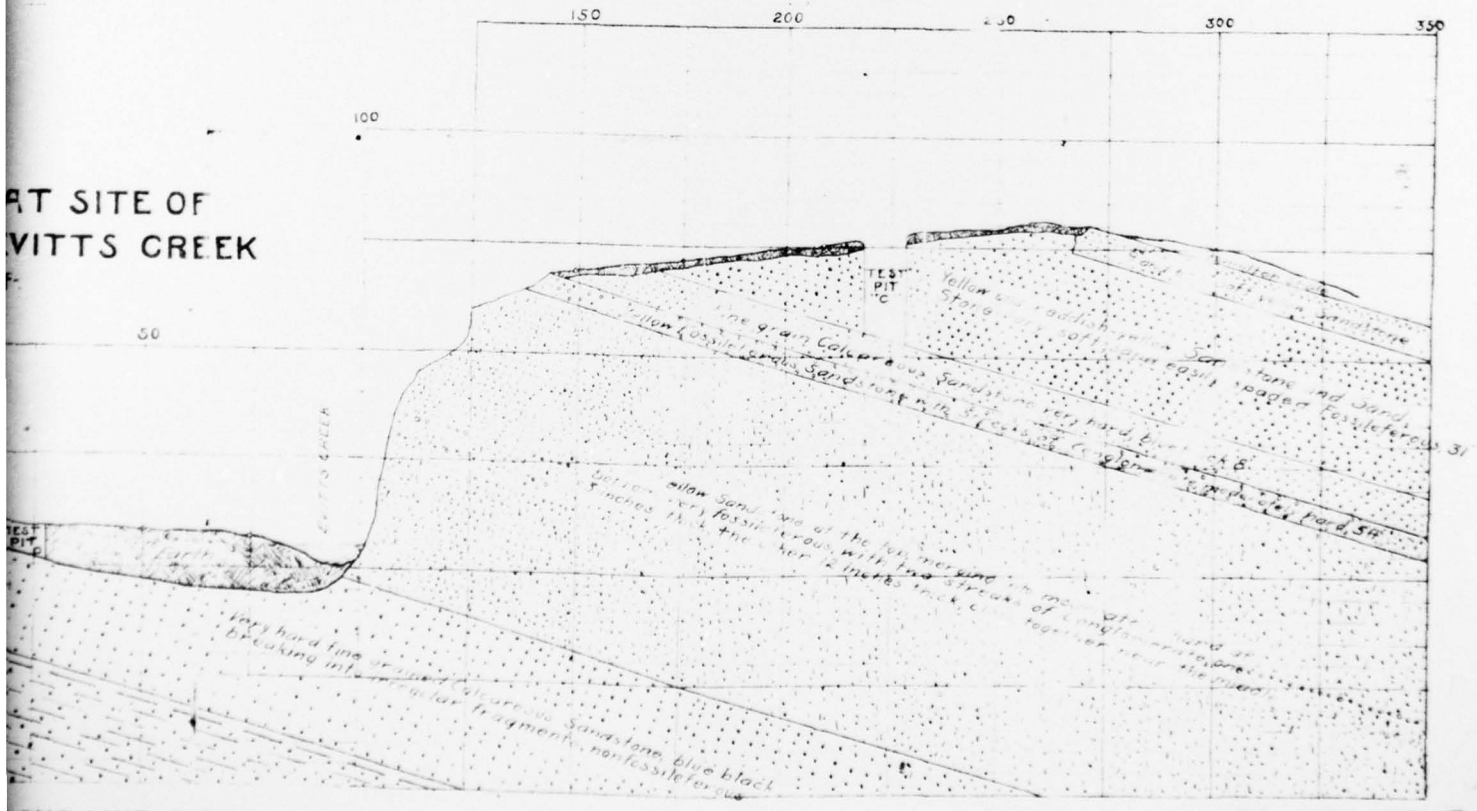
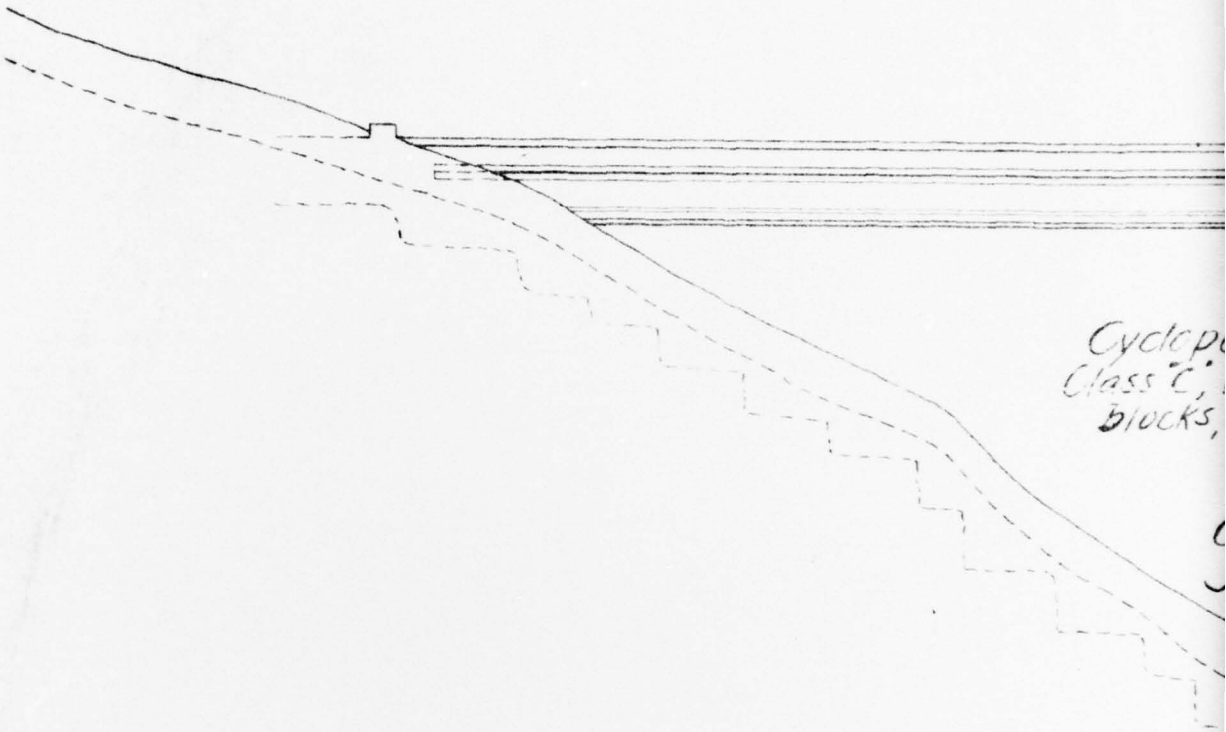


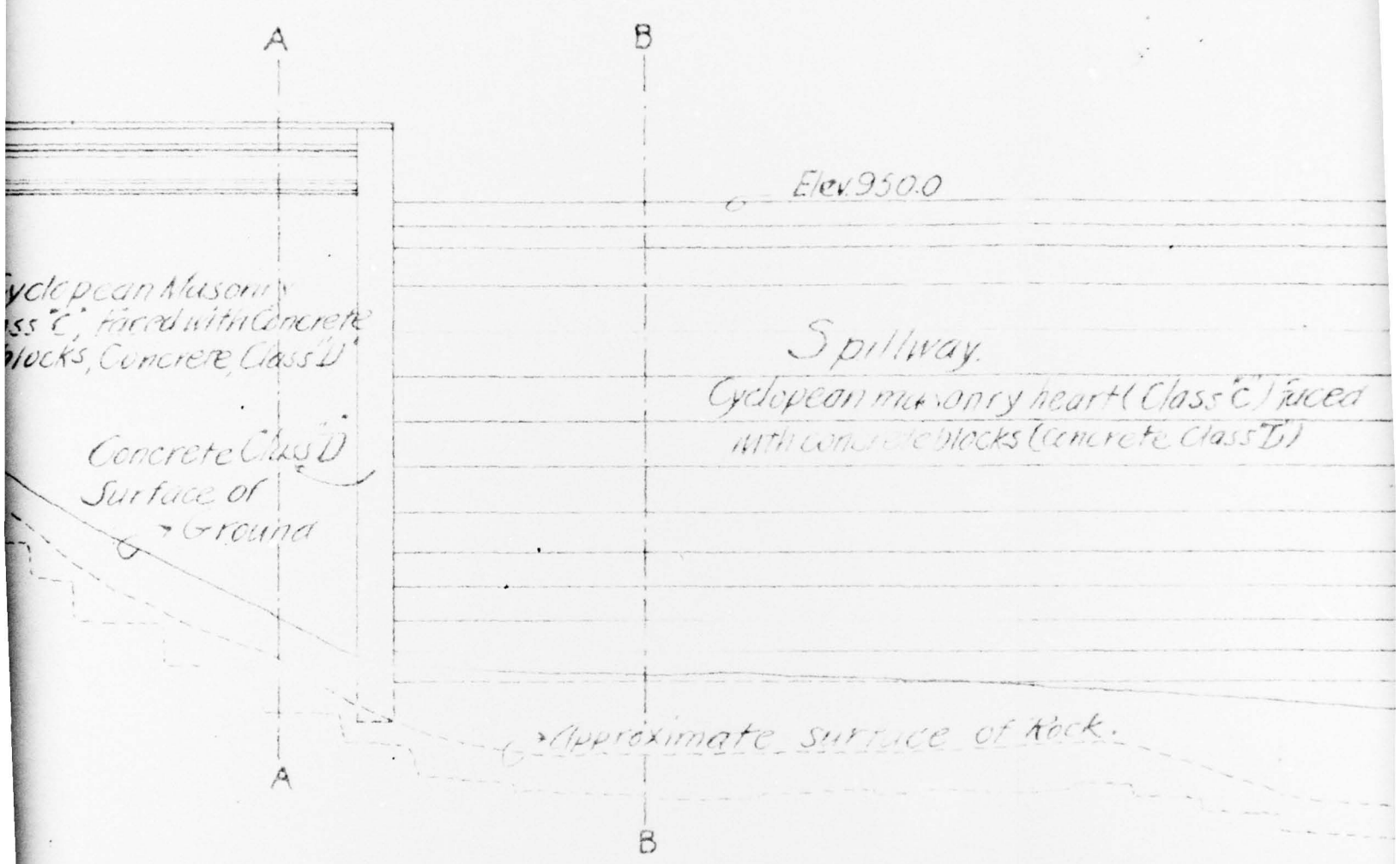
AT SITE OF
VITTS CREEK

LONG-LINE A-A

PLATE VII 2



PLAN



FRONT ELEVATION

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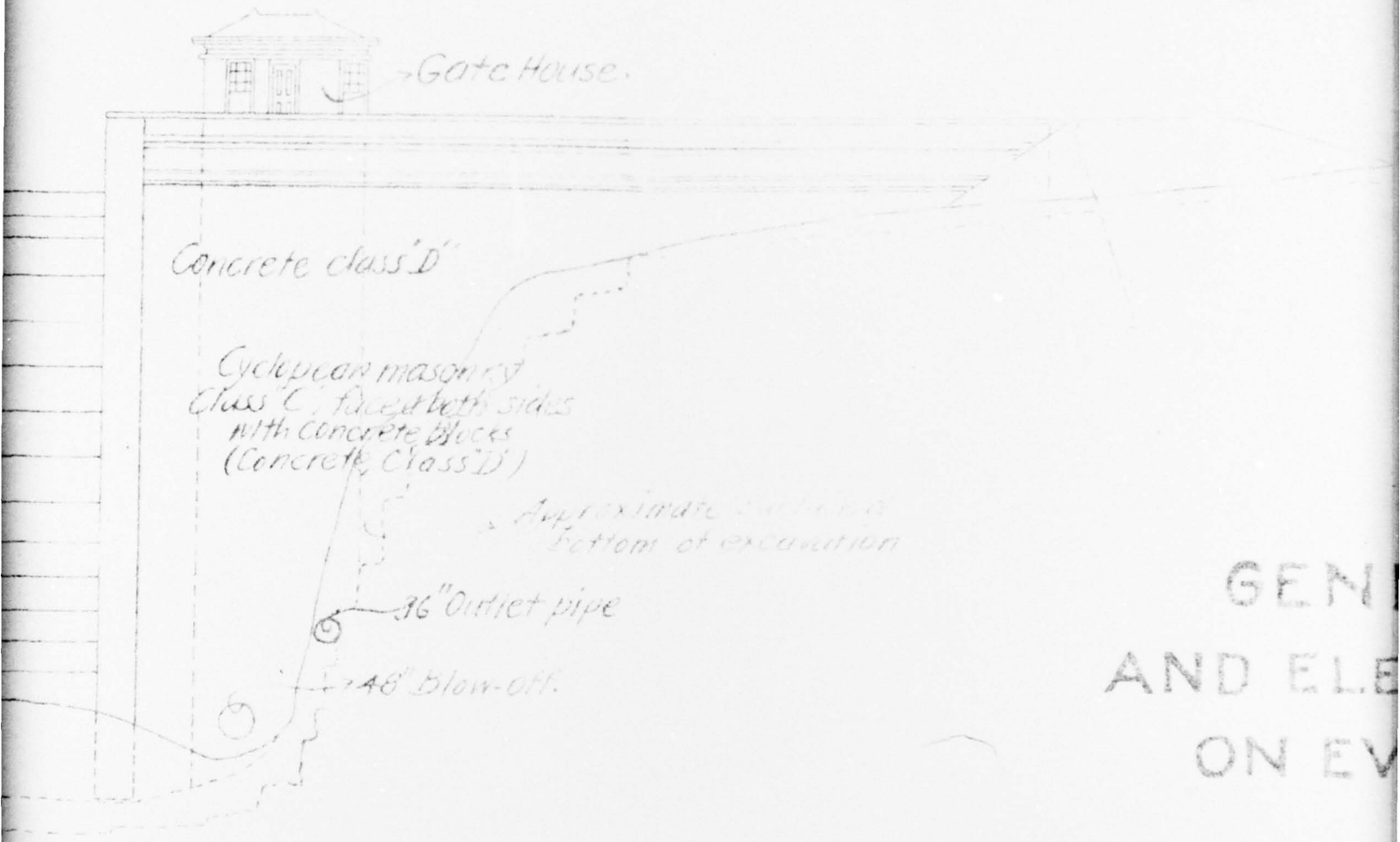


GEN
AND ELE
ON EV

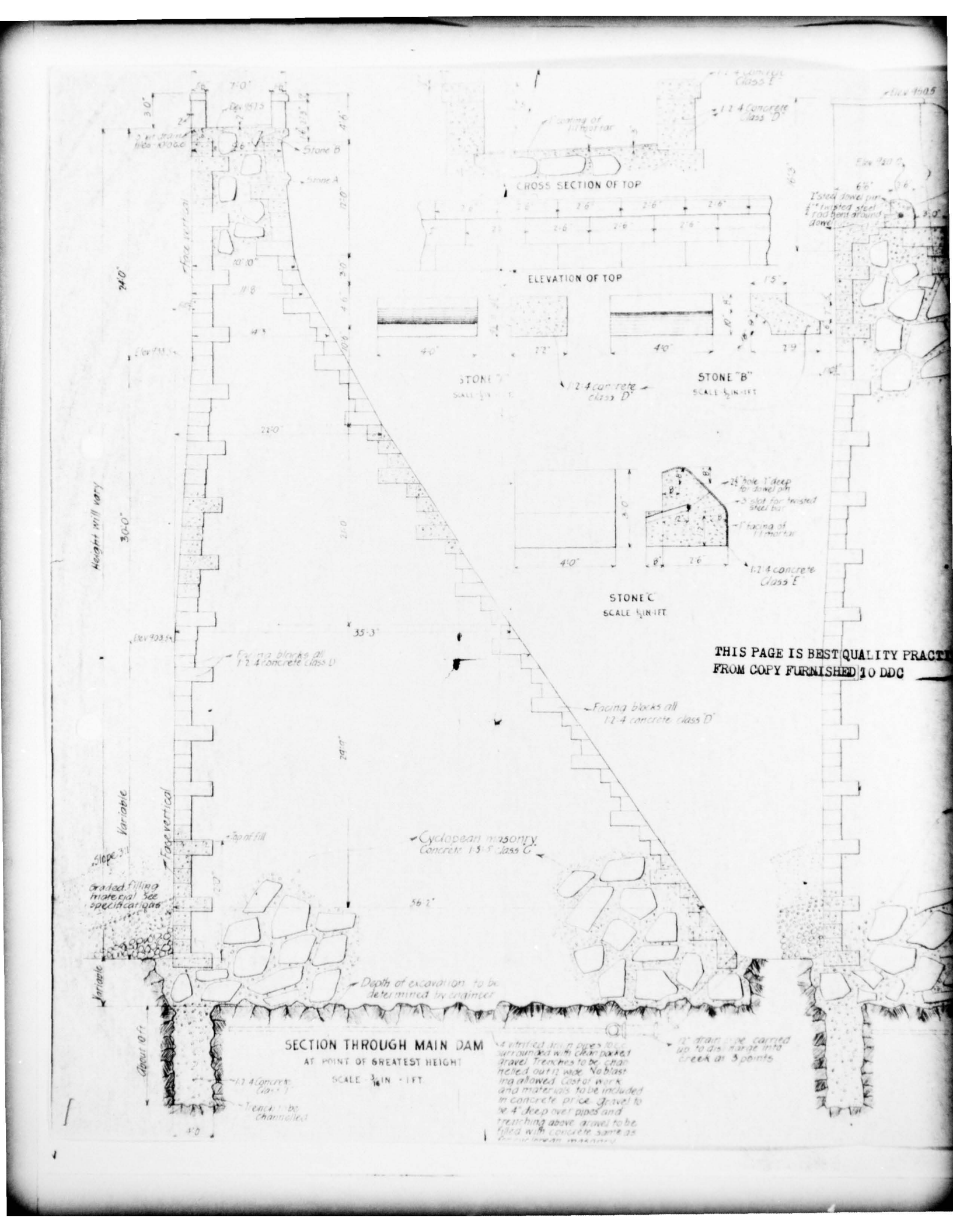
ERAL PLAN

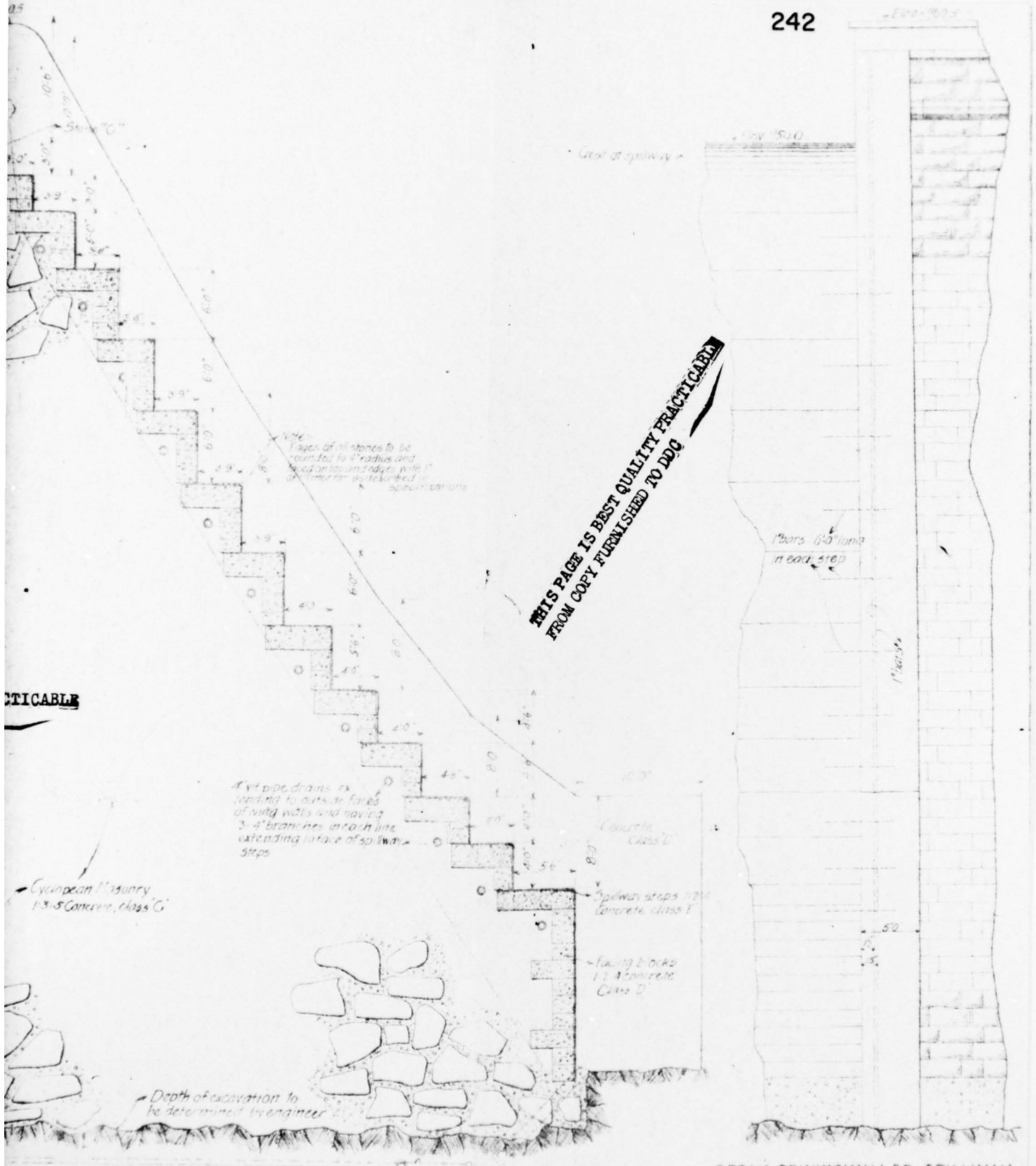
EVATION OF DAM

VITTS CREEK

Scale: 1"=20'

PLATE VIII 4



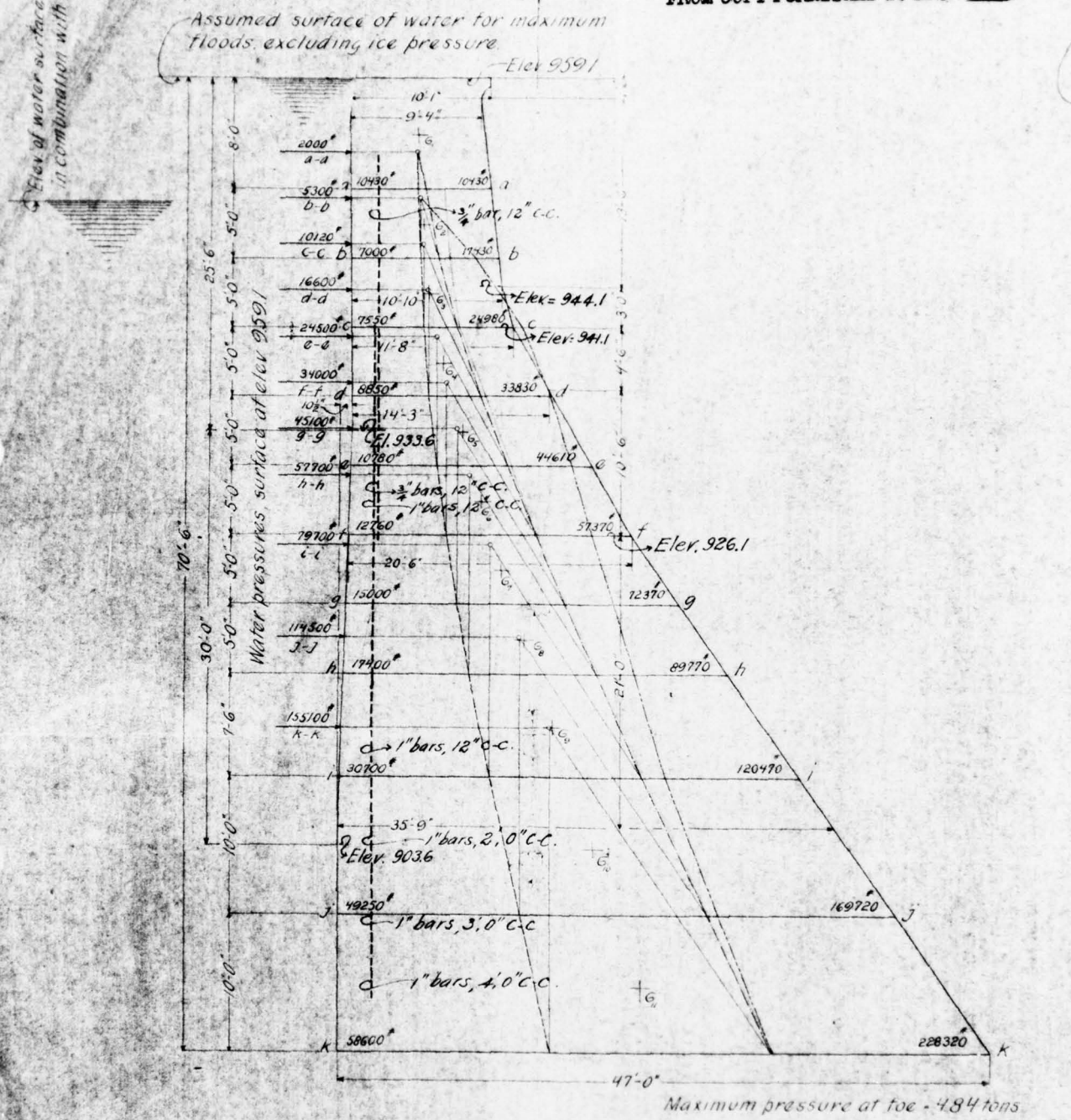


SECTION THROUGH SPILLWAY
SCALE - 3/16 IN. = 1 FT.

DETAIL OF WINGWALL OF SPILLWAY
SCALE - 3/16 IN. = 1 FT.

TYPICAL SECTIONS
THROUGH
DAM ON EVITTS CREEK

PLATE IX



Maximum pressure at toe - 4.84 tons per sq ft

SECTION ON LINE A-A, SHEET 7-a.

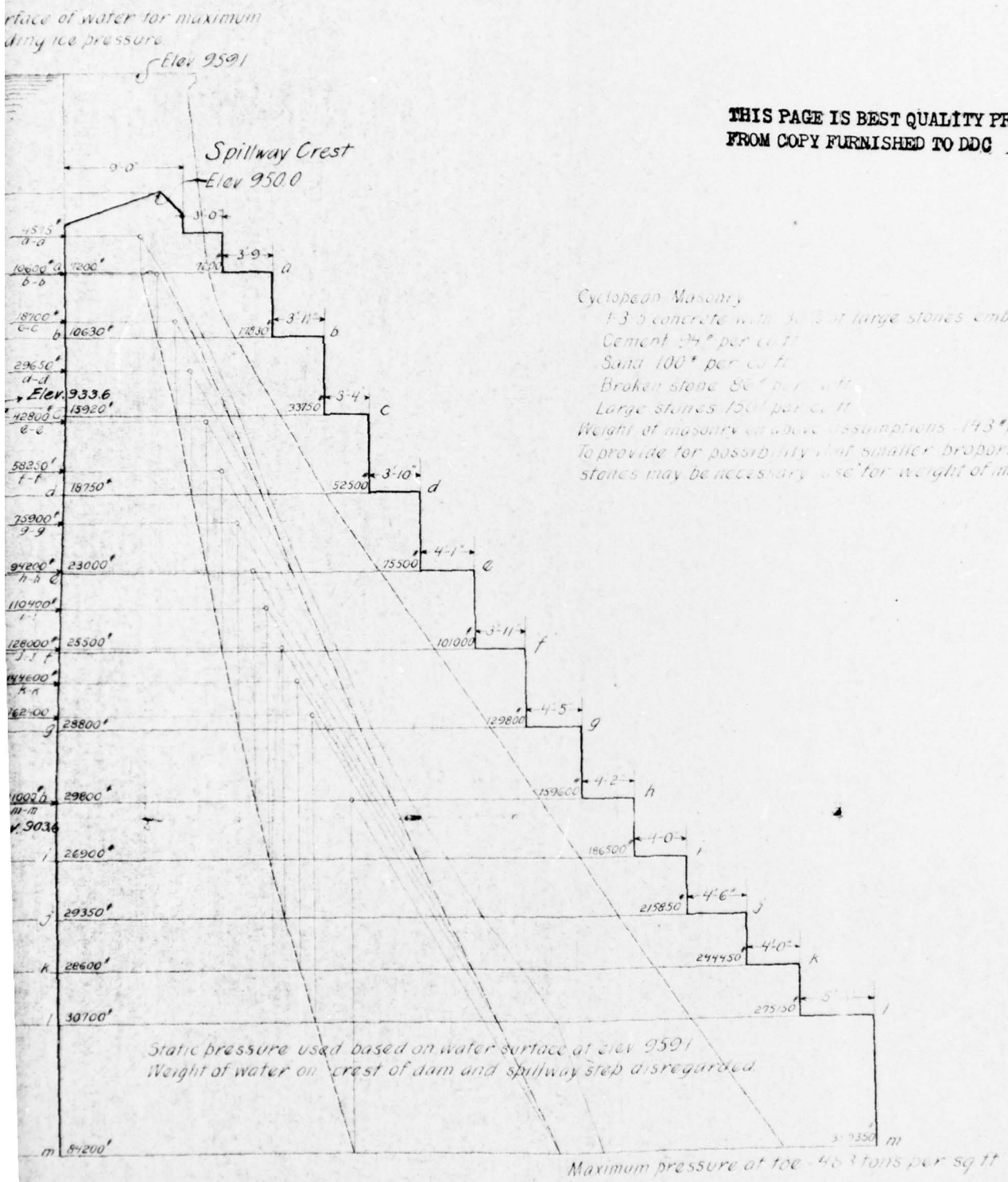
Limiting line of pressure, water surface at elev 9591, ice pressure not considered ————————

Limiting line of pressure, water surface at elev 9500 and ice pressure of 20000# per lineal foot applied 6" below water surface (elev 9495) ————————

Limiting line of pressure, reservoir empty ————————

Locus of outer "third points" ————————

STRA



SECTION ON LINE B-B, SHEET 7-a

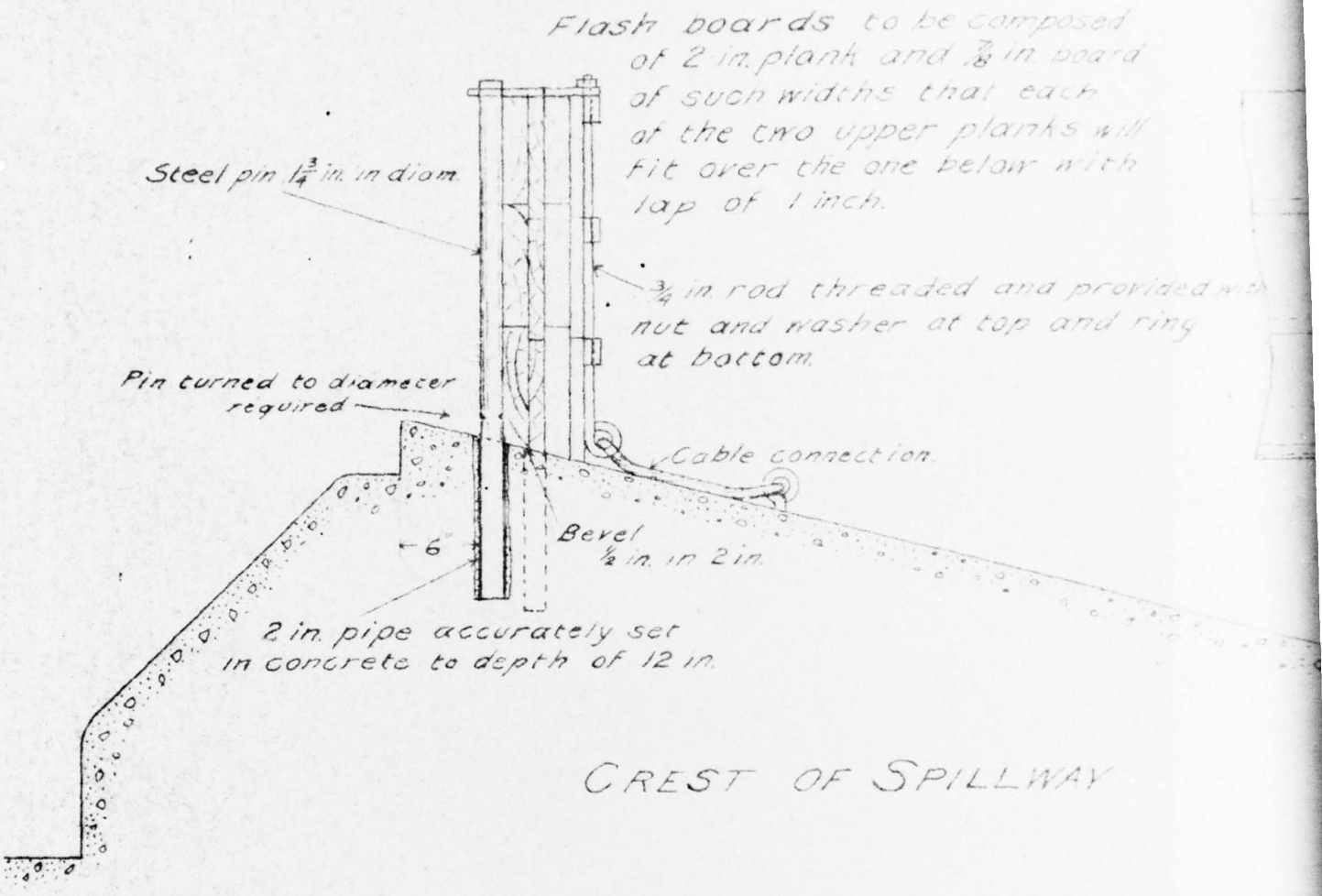
AINS IN EVITTS CREEK DAM

Scales
3/16" = 1'
1" = 30000"

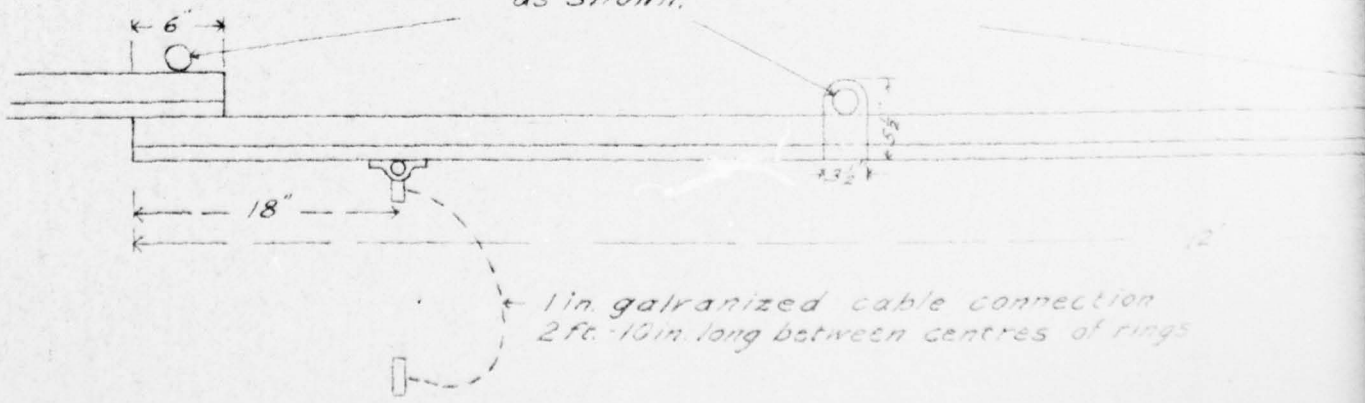
PLATE X

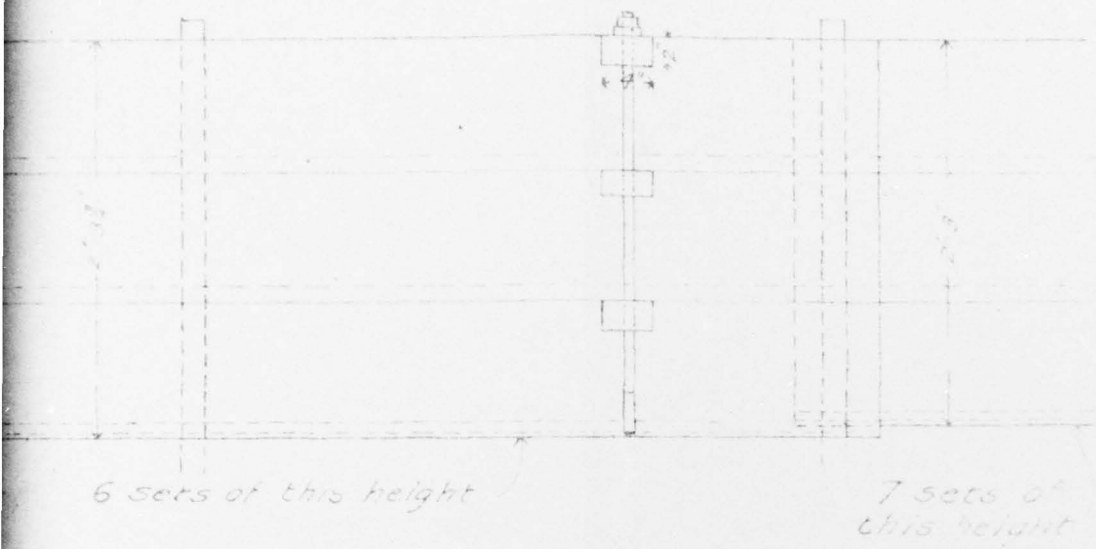
2

Office of James H Fuertes
New York N.Y. March 1912



CREST OF SPILLWAY





EVITTS CREEK WATER COMPANY
DETAIL OF FLASH BOARDS FOR
DAM AT LAKE GORDON
Cumberland, Md. Jan 4, 1926
J. L. Kimball Consulting Engineer

Scale 1 in = 1 ft.

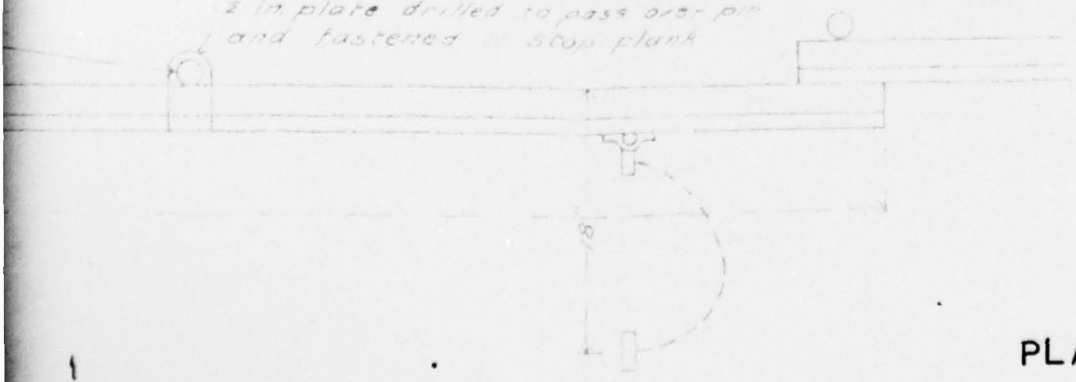
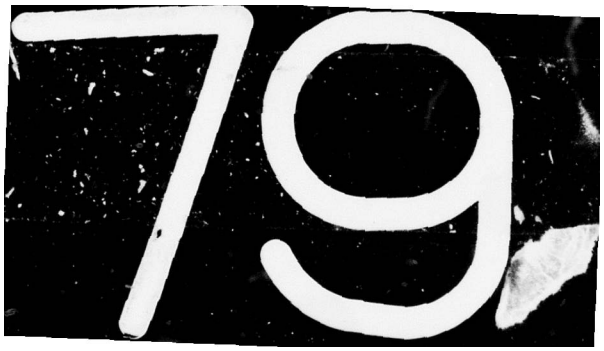


PLATE XI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